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FORTIFICATION

“CIVITAS PARVA ET PAUCI IN EA VIRI: VENIT CONTRA EAM REX MAGNUS ET VALLAVIT EAM, EXTRUXITQUE MUNITIONES PER GYRUM, ET PERFECTA EST OBSIDIO.

“INVENTUSQUE EST IN EA PAUPER ET SAPIENS, ET LIBERAVIT URBEM PER SAPIENTIAM SUAM, ET NULLUS DEINCEPS RECORDATUS EST HOMINIS ILLIUS PAUPERIS.

“ET DICEBAM EGO MELIOREM ESSE SAPIENTIAM FORTITUDINE.”—*Eccles.* (Vulg. Ed.) ix. 14.

“Doch ſeinen Muth muß Weisheit leiten,
Und Liſt muß mit der Stärke ſtreiten.”
—SCHILLER, (Kampf mit dem Drachen.)

“Be Counsel ever Valour’s guide,
And Art with Strength fight side by side.”

———— “Men that warring are
Should sett their Ettlin ever mair
To stand against their Fois’ Mycht,
Umwhyle with Strength, umwhyle with Slycht.”
—BARBOUR’S *Bruce*, Book ii.

FORTIFICATION

FOR

OFFICERS OF THE ARMY AND STUDENTS OF
MILITARY HISTORY

WITH

ILLUSTRATIONS AND NOTES

BY

LIEUT. HENRY YULE
BENGAL ENGINEERS

> "For all that, Sir Duncan, I would premonish you, as a friend, to trace out a sconce on that round hill, with a good graffe or ditch—it being the custom of the valorous Gustavus Adolphus to fight as much by the spade and shovel, as by sword, pike, and musket. Also I would advise you to fortify the said sconce, not only by fossie or graffe, but also by certain stackets or palisades."——LEGEND OF MONTROSE.

WILLIAM BLACKWOOD AND SONS
EDINBURGH AND LONDON
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TO

MAJOR WILLIAM ERSKINE BAKER

BENGAL ENGINEERS

BY

HIS ATTACHED FRIEND

H. YULE

PREFACE

THERE are reasons besides the Regulations of the Horse Guards, and of the India House, why a soldier should know something of Fortification and its uses, even though he should never be called on to line out a field-work, to design a citadel,* or, as a General in command, to decide on the merits of an engineering project. It is not well that soldiers should find themselves unacquainted with the alphabet of a branch of Military Science, some knowledge of which is essential to the comprehension of Military History; it is well that they should know a *Ramp* from a *Traverse;*[*] that they should have an idea of the purpose and construction of works which they may one day have to find their way into, or out of.[†] In war there may be many other occasions on which a knowledge of Fortification may enable an officer of infantry to do good service. "It deserves to be recorded," says Colonel Reid, "that the outposts of the 52d regiment, at Bayonne, had been so well fortified by a captain of that regiment, that the picquets had no occasion to retire till they had fired their sixty rounds of ammunition. This officer had taught himself to strengthen posts by barricades and other temporary expedients."[‡]

---

* Like a distinguished young soldier of our day. "It may easily be con-

A small impression of a work containing the substance of this was printed last year, for the use of the Scottish Naval and Military Academy at Edinburgh. The approval of some interested in the subject, and the impulse given

---

ceived how much I now felt the want of a military education, and that practical knowledge of field-fortification which every cadet acquires (if he has got any sense, and wishes to be a soldier, and not a clothes-horse for red-jackets) at either Addiscombe or Sandhurst. I had not had these advantages; and the consequence was that, though holding the commission of lieutenant in an army belonging to the most civilised nation of the nineteenth century, I was driven to imitate the system of fortification which one of the most barbarous races of Asia may have inherited, for aught I know, from the dispersed builders of Babel."—Major H. B. Edwardes' *Year in the Punjab*, vol. i.

[*] "Is that what you call a *Tramp?*" said a young officer, pointing to a certain part of a field-work thrown up in the last Indian war.

[†] "One of the repulsed parties in the attempt on Bergen-op-Zoom, (1814,) finding itself immediately under view and fire of a whole front, it was decided to withdraw; *but no officer being sufficiently acquainted with the details of fortification to point out the ſure retreat which the covered-way presented to their view,* they crowded into the communication to Fort d'Eau."—Jones's *Sieges.*

[‡] *R. E. Professional Papers*, vol. ii.

to such studies by late Regulations, have suggested its publication in its present enlarged form.

The principles of Fortification are few and old, and the details (of field Engineering at least) much the same now as they were when old Nestor counselled the "brass-mailed Greeks" to cast a palisaded intrenchment round their leaguer on the Trojan plain.* The aim of the author in this Essay has been to give principles and essential details in a natural and readable order; to exemplify those "old saws" by "modern instances;" freely to use biographical and other illustrative notices, with the view of giving something of life-like interest to a study which is too often vaguely regarded by soldiers as a dim compound of strange angular diagrams, and technical jargon.

These notices he has desired should form a prominent feature of the book, and he trusts they will not be thought out of place or of proportion. Even to many who have gone through courses of Fortification in their youth, the Vaubans, the Coehorns, and other heroes of the art remain mere *nominis umbræ*, with as little of personality attaching to them as to the authors of Euclid's Elements or of Cocker's Arithmetic. If further apology is wanted, a plea may be borrowed from the example of the Latin translators of Albert Durer's book on Fortresses, who interpolate in their version a long passage from Ovid on the wonders of Babylon, with this ingenuous preface :—

> "Offerimus tibi, candide Lector, elegantissimam Babyloniorum urbis arcisque descriptionem, in quam legendis Dureri præceptis tædii sublevandi causâ subinde, quasi in amœnum pratum, digredere!" †

---

* *Iliad*, vii.

† "We now present thee, Gentle Reader, with a delectable description of the city and palace of the Babylonian Kings, that when wearied with the perusal of Durer's prosy precepts, you may turn aside and expatiate here as in some pleasant meadow by the way."

Some of the biographical sketches, such as those of Vere and Navarre, will be found more full than can easily be met with elsewhere. Portraits of these, and others whose names are connected with the history of the art, have been added. Some even who are familiar with the history of these heroes, may be glad for the first time to make acquaintance with their features. The style in which they are executed will do no discredit to the artists* or to the book.

A Glossary of Military Terms (both modern and antiquated) has been appended. There are many lovers of military narrative who are not soldiers ; and both classes, if the author may judge from his own experience, must have found the want of a concise vocabulary of this nature.

There appeared room for a work of the size and scope presented here. Those who desire to pursue the study in greater amplitude of detail, may pass on to the brilliant Essay of Bousmard, or to the able and comprehensive Treatise of my old instructor, Major Straith.

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* Messrs Schenck and Macfarlane, of Edinburgh.

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† Kindly lent by Mr W. F. Watson, Edinburgh.

PRELIMINARY CHAPTER

The student should clearly understand the terms *Plan*, *Elevation*, and *Section*.

A *Plan* is a drawing which shows an object in its horizontal dimensions only; as it would be represented on a horizontal plane over the object, by vertical rays or lines, rising from every point in the object to intersect the plane. The common maps of countries or cities are *plans*. From a map of Europe you can ascertain the length of the chain of Alps, or the breadth of the Straits of Dover; but no application of the compasses will help you to learn from it the height of the one or the depth of the other.

An *Elevation* represents the exterior dimensions of the one side of an object; it is supposed to be described by *horizontal* rays or lines passing from every point of the object to intersect a given vertical plane.

A *Section* of an object in a given direction, either vertical or horizontal, is, in the former case, the elevation, in the latter case the plan, which the object would afford if supposed to be cut through in the given direction.

A *Plan* of Edinburgh Castle would exhibit all the roads and courts, horizontal outline of the hill, and all the ins-and-outs of the batteries and walls; but it would give no information as to the height of rock, walls, or barracks. An *Elevation* would show the heights of rock and walls, &c., visible on any one side, and the architectural appearance of the buildings. But neither plan nor elevation would give us information as to the thickness of the retaining walls, or the degree of slope which may have been given them. Let us be furnished with a *Section* directed vertically across the works in any part, and we shall then know the thickness, and inclination of the walls at that part.

So, again, a *Plan* of a cylindrical pillar will be a simple circle; a *Vertical Section* of it will be a simple upright rectangle; an *Elevation* will be a similar rectangle, shaded so as to indicate the roundness of the surface.

A *Section* oblique to the face of a building will plainly not show the true thicknesses. Sections are, therefore, unless for some special reason, usually made perpendicular to the face of the structure which is to be exhibited, and such a perpendicular section is often termed a *Profile*.

The following problems, being of frequent occurrence in plan-drawing, must be understood before proceeding with the practical part of the study.

PROB. I.

To divide a straight line of given length into any given number of equal parts.—Let AB be the line, and let it be required to divide it into six equal parts. From A draw AC, making any angle with AB, and through B, on the other side of the line AB, draw BD, parallel to AC. On AC set off any convenient length five times from A towards C, and set off the same length five times on BD from B towards D. Join the point 1 in BC to point 5 in BD, 2 in AC to 4 in BD, &c. The intersections of these lines with AB will divide it into six equal parts.

PROB. II.

To bisect a given line AB. From the extremity A as a centre, with a radius greater than half AB, describe an arc on both sides of AB. With the same radius from the centre B, describe an arc cutting the former in two points C and D. Join CD by a line cutting AB in E. AB is bisected in E.

PROB. III.

To raise a perpendicular to AB, from any given point in it.—Let E be the point. Set off on each side of E, EA, EB, equal to one another. Proceed as in the last problem. CD will be perpendicular to AB in E.

Or; let P be the point in the line AB. Take any point C above the line as centre, and with radius CP describe a circle cutting AB in P and D. Draw DE through C, to meet the circle in E. Join EP, which will be the perpendicular required.

Or; make PD=3 on any scale. With P as centre and 4 on the same scale as radius, describe an arc; and with D as centre and 5 as radius, describe another arc, cutting the first in E. EP as before will be the perpendicular.

PROB. IV.

To let fall a perpendicular on a given line from a given point P, outside the line.—Take C, any point in the line, as centre, and with radius CP describe an arc, cutting the line in D. From D make the segment DE below the line=DP above it. Join PE, which is the perpendicular.

Prob. V.

To make an angle equal to a given angle.—Let CAB be the given angle; at the point D, in the line DE, it is required to make an angle= BAC. From A, with any radius describe an arc cutting AB, AC in *a* and *b:* and from D, with the same radius, describe an arc cutting DE in *c*. Make *cd* on the latter arc equal to *ab*, and through *d* draw DF. The angle FDE= BAC.

Prob. VI.

To bisect a given angle BAC.—From the angular point A, describe an arc cutting AB, AC in *b* and *c*. From *b* and *c* as centres, with any one radius, describe arcs intersecting in D. Join DA, which will bisect the angle.

Prob. VII.

From a given point, P, outside a circle, to draw a tangent to the circle.—Draw a line PC joining P to the centre of the circle. Bisect PC in B, and describe a simicircle on PC, cutting the original circle in T. PT will be the tangent.

Prob. VIII.

*To construct a square on a given line AB.**—From A and B as centres, and AB as radius, describe arcs intersecting in C. From C, with the same radius, describe a circle intersecting the former arcs in D and E. From D and E describe arcs intersecting this circle in F and G. Join AF, BG, which will intersect the arcs first described in H and I. Join HI; AHIB is the square required.

Prob. IX.

To construct a pentagon on a given line AB. — Make the angle ABC = 108°, and make BC = AB. Bisect AB, BC, by perpendiculars meeting in F, and from F describe a circle passing through A, B, C. Then, with the length of the side AB set off AE, CD, ED, on the circumference completing the pentagon.

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* From Blackie's *Engineer and Machinist's Assistant.*

PROB. X.

To construct a hexagon on a given line AB.—From A and B, with the radius AB, describe arcs intersecting in G. From G as centre, describe a circle passing through A and B. Set off five chords, BC, CD, DE, EF, FA, each = AB, which will complete the hexagon.

PROB. XI.

To construct an octagon on a given line AB.—Draw AC = AB, and making with it an angle of 135°. Join CB, bisect it in D, and describe a semicircle on CB. Let a perpendicular from the middle point of CB cut the semicircle in E. Take E as the centre, and describe a circle with the radius EB passing through C and B. This circle will circumscribe the octagon, which may now be drawn by cutting the arc into eight segments, having the chord = AB or BC.

PROB. XII.

To draw a rectangle, having a side of given length, and a given diagonal AC.—On AC describe a semicircle. From A, with radius equal to the given side, describe an arc cutting the semicircle in B, and join BC. Draw AD, CD parallel to BC, AB, which will complete the rectangle.

The angle of any polygon may be found from the property of such figures, that the sum of the angles of any polygon is equal to twice as many right angles as the figure has sides, less four.

The following technical terms require explanation :—

A *Salient Angle* is one directed outwards; a *Re-entering Angle* one directed inwards. Thus A forms a salient angle, V a re-entering angle, as regards the reader.

An imaginary line bisecting an angle in fortification is called the *Capital.*

A line connecting the rear or interior extremities of a work is called the *Gorge.*

The *Relief* of a work is the difference in level between the lowest and the highest points on the profile of the work.

The *Command* of a work is its height above the natural surface or *plane* of *site*. The command of one work over another is the amount by which the height of the first exceeds that of the second.

Other terms will be defined as necessity for their use arises in the body of the book. This seems preferable to discharging a whole battery of technicalities in one salvo. Where, in the course of the work, a definition has escaped the reader, it may be found by reference to the Index; if it should have escaped the author, the Glossary at the end may be referred to.

As the arrangement of defensive works must depend greatly on the ranges of the weapons with which they are armed and attacked, it is well that the reader should have an idea of what these are. The effective range of musketry is from 180 to 200 yards, and at 300 it is not much regarded.

The large arms called wall-pieces, or rampart muskets, used in the defence of fortresses, strike with full effect at from 400 to 500 yards.

The following table shows the ranges of the most common pieces of artillery:—

FIELD ARTILLERY.

	RANGES IN YARDS.	
	At Point-blank.	At 4° of Elevation.
6-pounder gun,	200	1200
9 or 12 pounder do.,	300	1400
12-pounder howitzer,	200	1000
24-pounder do.,	250	1025

HEAVY ARTILLERY.

	RANGES IN YARDS.	
	At Point-blank.	At 4° of Elevation.
18-pounder gun,	360	1600
24-pounder do.,	360	1670
32-pounder do.,	380	1730
		12° of Elevation.
8-inch howitzer,	—	2000
10-inch do.,	—	2410

The extreme range of the small brass mortars, called *Royals* and *Coehorns*, is about 600 yards; of the 8-inch iron mortar, 2000; of the 10-inch, 2400; of the 13-inch, 2900 yards.

The heaviest description of artillery—such as 56-pounders, and the 8-inch and 10-inch guns lately introduced into the service for the armament of steamers and the defence of coasts—fired at considerable elevations, range to distances of 4000 and 5000 yards.

CHAPTER I.

OBJECTS AND ELEMENTARY FEATURES OF FORTIFICATION.

> "Hee (Gustavus Adolphus) had the true Art (almost lost) of encamping, where hee would lye in his Trenches in despight of the Enemy, Keeping the Clocke of his own Time, and would fight for no man's Pleasure but his own."——FULLER'S HOLY STATE.

THE art of Fortification has been practised, we may suppose, ever since war has existed among men.

Its object is defined by the literal meaning of the term—*Fortify*, *to make strong*. It is the art of economising force in war—the art which gives strength to a military position by a right expenditure of labour, and so enables the body of troops which occupies that position to resist a more powerful force. This strength is attained in proportion as,

1*st*, The defender's position is protected from the observation and missiles of his assailant.

2*d*, The assailant's access to the position is difficult and obstructed.

3*d*, The defender's position affords him every advantage in observation of his assailant, and in the direction of his troops and weapons against him.

These three conditions are essential to the idea of good fortification. Let us call them briefly *Cover*, *Inaccessibility*, and *Vantage.*

Often nature or accident, the form of the ground's surface, or the disposition of buildings already existing, will afford, in greater or less degree, and in suitable situation, these requisites.

Where this is the case, the soldier will use the art of fortification to improve the advantages so afforded by nature or accident, and to obtain those in which the position is deficient. Where a place, which it is of importance to defend, has derived from nature or accident none of these advantages, the art of fortification must create them.

The application of the art to objects of temporary moment—such as in strengthening the flanks or front of an army in the field, in the defence of a bridge, a village, or the streets of a city, or in the works employed to cover the attack of any military position—is called by us Field Fortification; by the French, aptly, *Fortification Passagère*, or Transitory.

In its application to strengthen positions of lasting importance—such as cities, harbours, arsenals, frontiers of kingdoms—it is termed Permanent Fortification.

The fundamental principles of these two kinds of fortifications are the same. Their differences arise from the hasty construction generally required for works of field fortification, the lighter quality of metal with which these are usually armed and attacked, and the much greater expense which is justifiably incurred on works intended for permanent service.

But these distinctions cannot always be accurately marked. For economical or other reasons, defences partaking of the nature of field fortification may be constructed in sites of lasting importance; and, on the other hand, field-works which are intended to make a protracted defence—as occupying positions which are the keys of success in a campaign, or which are likely to retain their consequence throughout a long war—are often constructed so elaborately, as to approach in character to permanent fortification. Such works the French call Mixed.

A great variety of materials has been employed in the construction of works of fortification, such as each region or the occasion furnished most readily to hand. Wooden blockhouses have been employed in the forests of the Canadian frontier; stockades of bamboo or timber in the Burmese and New Zealand jungles, and on the hill-tops of Nepaul; sun-dried bricks and mud in the hot plains of the East; heaped paving-stones in the streets of Paris; cotton packs in the defence of New Orleans. Tiers of camel-saddles have been turned to account as breast-works in India. The defences of permanent works in the classical and middle ages were of masonry. Opposed to modern artillery, masonry is, unless of enormous bulk, easily destroyed; from its liability to fly in splinters, and to fall in masses, it is very dangerous to its defenders; and it is absolutely incapable of prompt repair.*
Hence, since the establishment of gunpowder as the main engine of modern war, earth has been the chief material of most fortifications; and the consideration of earthen works forms the principal portion of the study of the art.

The first essential of fortification is Cover. A bank thrown up to give cover from an enemy's fire is called a *Parapet.* The parapet should be high enough to cover the tallest man who will stand behind it, and thick enough to stop the heaviest shot that is likely to be fired against it.

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* The rebuilding of the whole flank of the Orange bastion at Gibraltar, (120 feet in length,) during the siege of 1782, was probably an unexampled operation, carried on as it was in the face of a powerful artillery.—Drinkwater's *History,* chap. viii.

To fulfil the first condition, parapets are usually made from 7½ to 8 feet high. Not that this is the usual stature even of grenadiers, but because some additional height must be allowed for the protection of persons within the parapet from shot pitching over its crest, (a constant occurrence, as the course of every bullet is a curved line,) because the interior should be concealed from the view of a horseman, and also in anticipation of the reduction which the height of the parapet will suffer from exposure to continued fire. Where time presses, it may not be practicable to provide against these contingencies, and, in such a case, a 6-foot parapet must suffice.

The condition of thickness may be determined from the following table, which shows how deep each calibre of shot has been found to penetrate into an earthen bank, and what additional thickness of earth it is desirable in each case to allow:—

Calibre.	Depth of penetration.	Requisite thickness of parapet.
Musketry,	1′ 6″	3′ 0″
Artillery, 6 pounder,	3′ 6″ to 4′ 6″	6′ 0″
... 9 ...	6′ 6″ to 7′ 6″	9′ 0″
... 12 ...	8′ 6″ to 10′ 0″	12′ 0″
... 18 and 24,	11′ 6″ to 13′ 0″	18′ 0″

From this results a rule easily remembered—that a parapet should have a foot of thickness for every pound-weight of the shot which it is intended to resist, from 6-pounders up to 18's. Parapets of permanent works, which, of course, must be prepared for any weight of metal, are usually from 18′ to 20′ thick.

It is plain that the earth, to form the parapet, may be either dug from the inside and thrown outwards, (Pl. I., figs. 1, 2, 3, 4, 6, and Pl. II., fig. 18,) or dug from the outside and thrown inwards, (as in Pl. I., figs. 7, 8, 9, 10, and Pl. II., figs. 20, 21.)

In the former case, protection will be most speedily obtained; for every foot in depth of earth that is dug and thrown out gives two feet of cover.* This protection, however, will be afforded only to troops actually standing in the excavation.

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* See figs. 1 and 2.

In so far cover—which we have said to be the first object in fortification—is attained with great rapidity; the second object, inaccessibility, is not attained. The third, advantage in the use of troops and arms is, in some respects, rather lost than gained; for the defender, standing in a hole, is unfavourably placed both for watching his assailant's advance, and for a hand-to-hand struggle at the parapet. Hence such works are to be used where *cover* is the main object, or its rapid attainment of the greatest importance. Such cases are the trenches excavated to cover the advance of troops besieging a fortress; lines extending between two works of a stronger description to protect their communication with one another; breast-works thrown up on the spur of the occasion to block up a road, or assist the defence of a position, or to cover troops from artillery fire in the early part of a general action. One advantage of these trenches is, that their construction permits troops to charge over them without difficulty, whilst their fire is low and likely to be deadly. Such are the lines which the Sikhs seldom fail to commence instantly on occupying a position in front of an enemy, multiplying and strengthening them day by day when time is afforded.*

A good adaptation of such works in the field is on the crest of a hill descending in a slope towards the enemy. Here nature gives vantage, with, in some degree, difficulty of access; and a low parapet will suffice to cover from an enemy below, troops not only in the trench, but in its rear also.†

In soil affording but a shallow surface of earth that can be excavated, cover will be most rapidly attained by digging a trench outside and inside simultaneously.‡ This, however, has the inconvenience of affording cover to the assailant when he reaches it.

In the second case, where the earth is dug from the outside, a greater amount of excavation is required to produce cover, but the excavation itself, or *ditch*, as it is called, becomes an obstacle to the enemy's advance—*i. e.*, gives in greater or less degree *inaccessibility*. And in works deliberately executed, this is the usual construction, as the ditch affords facilities for the disposition of other obstacles to retard attack. Time pressing, however, the interior excavation is to be preferred, because, in whatever state of progress the work is interrupted, it gives some cover and benefit; whereas a half-finished work, with exterior excavation, will be useless to defenders, and may give good cover to the enemy.

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* See Note A, Sikh Intrenchments.

† See fig. 3.

‡ See figs. 5 and 19.

It has been stated that the usual height of a parapet is 7½ feet. As most works are intended for active as well as passive defence, it is obvious that some arrangement must be made to enable men to fire over such a height. For this purpose a step of earth is raised all along the inside of the parapet. 4¼ to 4½ feet is the height over which men of average stature can fire a musket conveniently, and this fixes the height at which the step of earth must stand below the top of the parapet. This *banquette*, as the step is called, is usually made from 3 to 5 feet wide; and the slope to the rear, that it may be readily ascended, has a base equal to twice the height. Thus, in fig. 11,* which represents the usual form of a parapet with its ditch, as seen in profile and perspective, *e f g* is the banquette; *f g* the step itself, being called the *tread* of the banquette; and *e f* the *slope* of the banquette. The parapet *a b c d* is formed in three slopes—viz., an upper or top slope, an outer, and an inner slope, called technically, the *superior*, *exterior*, and *interior* slopes. There are certain general rules for the degree of inclination given to these slopes, which, as they depend on fixed reasons, do not vary much in their application to different works.

a b, the interior slope, is made very steep, that men may more couveniently stand close to it to fire over the parapet. Its usual slope is ⅓ to ⅕ the height; and as earth will rarely stand at such an angle, it becomes necessary to *revet* or face the slope with turf, timber, or other material. In permanent works, the interior of the parapet is often built perpendicular with masonry; but this is not desirable, as the splinters of masonry, struck by shot or shell, are destructive to the defenders.

The upper edge *b* is called the *crest of the parapet*, and generally the upper edge of any work or slope is called its *crest.*

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* Plate I.

b c is the superior slope. The more it is depressed towards the front, the more closely under the parapet can the ground before it be seen and defended. But if a very great depression be given to the slope, the crest *b* will become very sharp, and liable to rapid destruction. Hence, the depression usually given is $\frac{1}{6}$ of the breadth, and it is not advisable that it should exceed $\frac{1}{4}$.

The exterior slope *c d* should not have a greater inclination than the soil will stand well at. In imaginary profiles, the base is usually made equal to the height.

The inner side of the ditch *h i* is called the *escarp*, and the outer side *k j* the *counterscarp.* The steeper these are, the greater obstacle will the ditch be to an enemy. Hence, in permanent works, unless the ditch be full of water, both escarp and counterscarp are always walls of masonry. Sometimes a level path *d h* is left between the parapet and ditch. This is called a *berm.* It is necessary in some soils to prevent the earth of the parapet from slipping into the ditch, and it is a great convenience to the working parties when forming the parapet. But it is also too convenient as a landing for assailants.

Sometimes a work called a *glacis* (*k l*) is thrown up on the outside of the ditch, descending outwards in a gentle slope to the level of the country, or *plane of site*, as it is technically called. The glacis covers the lower part of the inner works from the enemy's fire; and when the edge of the counterscarp would otherwise be below the range of fire, the sloping rise of the glacis serves to bring it and the whole of the ground adjoining the outside of the ditch under the observation and fire of the parapet.

Where the parapet is thrown up from interior excavation, the banquette will be represented by a step cut in the outer side of the trench, or left like a berm between trench and parapet.* Fig. 1 shows the least amount worth noticing of cover for troops; figs. 2 and 3, better cover, though also from interior excavation. Fig. 6 represents the minimum of cover for guns; figs. 7 and 8, parapets thrown up from outward excavation for defence against musketry; figs. 9 and 10, for defence against artillery. When no great thickness of parapet is required, and time is afforded, it may be desirable to increase the inaccessibility of the work by deepening the ditch, beyond what is needed to give earthfor cover.* The additional earth may be used in raising the parapet to a greater height, and the ascent to the banquette may be broken into two or more steps.

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* See figs. 2, 3, 4, 5.

In nearly all the works of a permanent fortification, the parapet is raised on a terrace or bank of earth, sufficiently wide to afford space for the movements of the defenders and the working of their artillery. This bank is called the *Rampart.* It gives greater command to the works, where there are several lines enabling the interior line to overlook, and possibly to fire over, those which are exterior to it. Its height, usually protected by a lofty masonry escarp, renders surprise difficult, whilst it covers buildings within the fortress from direct fire. The level terrace of the rampart is called its *Terrepleine;* and the slope which terminates it on the inner side is the *Interior slope of the Rampart.* As this is usually steep, roads up it are made at intervals, with a gentle inclination, for the convenient ascent of troops and guns. Such roads are termed *Ramps.*

It has been explained how infantry are enabled to fire over a 7½ foot parapet, by the aid of the banquette; it remains to be shown how artillery fire can be directed from behind a similar parapet. The height of a gun's muzzle varies from 2′ 6″ to 3′ 9″. It is clear, therefore, that either the gun must be raised so as to fire over the parapet, or the parapet must be cut down so that the gun shall fire through it.

The former method is carried out in two ways. Sometimes the gun and its carriage are mounted on a frame of massive timber, so high that the muzzle clears the crest of the parapet. The timber frame is fitted with trucks or wheels, moving on a semicircular rail, so that the fire of the gun can be directed to right, left, or front, whilst the gunners remain covered by the parapet. This arrangement is called a *Traversing Platform.* It is evidently quite unfit for operations in the field. More commonly a terrace of earth is raised behind the parapet, high enough for the gun placed on it to clear the crest. This terrace is called a *Barbette.* Short ramps lead to it from the terrepleine below. This construction is much used at salient angles, as the gun so mounted has great facility in sweeping to right or left. But the gunners are exposed from the leg upwards. Figs. 12, 13, 14 show a *barbette* for one gun, in Plan, Section on the capital, and Perspective.

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* See fig. 7.

When the second method is adopted, or that of the gun firing *through* the parapet, the cuts made for that purpose are termed *embrasures.* The *neck*, or part next the gun, is made narrow, the embrasure *splaying* or widening towards its mouth, in order to give the gun some range to right and left. The lower part, or *sole*, inclines from the neck downwards, so much as is necessary to allow of the gun being fired at its greatest admissible degree of depression, should that be desirable; *i. e.*, 1 in 6, or nearly 10°. But as in field batteries, generally on or below the ground level, this is unnecessary, the slope of the sole is usually about ½ an inch in a foot. In batteries for ricochet, where the guns are elevated, the sole of the embrasures may even slope upwards to the front. The mass of parapet between two embrasures is called the *merlon.* The inner boundary of the sole is the *sill;* the sides are *cheeks;* the part of the interior slope left under the muzzle of the gun is called in French the *genouillère.*

To lay down an embrasure, first draw it in profile, as in fig. 17.* The height of a gun's muzzle determining the height of the sill *a* above the ground, make it 3 feet, and draw *a b* for the sole with an inclination, say of 1 in 9. In plan (fig. 15) draw *c d*, *e f*, for the positions of the sill and mouth as determined by *a b* in section. Draw *A B*, *the line of fire*, whether that be perpendicular or oblique to the direction of the parapet. On each side of the line of fire, on the line *c d*, set off 1 foot for the width of the sill. At 10 feet from the sill, raise perpendiculars of 3′ on either side the line of fire; draw lines *k m*, *l n*, through the extremities of these perpendiculars to meet the line *e f*. The form of the sole is now traced. The cheeks slope outwards 1″ in a foot at the neck, and have a slope equal to their height at the crest of the exterior slope.

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* Plate II.

Guns in embrasure should not be at less intervals than 18 feet from centre to centre.

The disadvantages of embrasures are, the narrow range which they allow to guns placed in them; their form, which acts as a funnel to receive the enemy's shot; and the weakness entailed on the parapet by these cuts in it, rendering it liable to rapid destruction from the enemy's artillery, as well as from the concussion of the discharges at the embrasures themselves. Sea-batteries should always be in barbette, or on traversing platforms, as a limited range of fire would be of little use against ships. Guns intended to command only a definite limited space, such as a ditch, a bridge, or the face of an adjoining work, may be suitably placed in embrasure.

Figs. 18, 19, 20, and 21 are profiles of various batteries in use, and illustrate what has been said of interior and exterior excavation. In fig. 18, called a *sunken* battery, excavation is entirely from within, the gun standing in the trench, and the natural surface forming the sole of the embrasure. Fig. 19, the *half-sunken*, is, like fig. 5, excavated partly from without and partly from within. Fig. 20, the *elevated* battery, is excavated entirely from without, the guns standing on the natural surface. In (fig. 21) the *cavalier* battery, the excavation is from without, and the guns are raised on a rampart.

CHAPTER II.

PRINCIPLES OF OUTLINE AND GENERAL RULES EXPLAINED.

DEFILADE.

> "Ambitum muri directum veteres duci noluerunt, ne ad ictus arietum esset dispositus; sed sinuosis anfractibus, jactis fundamentis, clausere urbes; crebrioresque turres in ipsis angulis ediderunt; propterea quia siquis ad murum tali ordinatione constructum, vel scalas vel machinas voluerit admovere, non solum a fronte, sed etiam a lateribus, et prope a tergo, veluti in sinum circumclusus opprimitur."——VEGETIUS, iv. 2.

WE must now say something of the *trace*, or outline in plan, given to works of fortification.

It is plain that at any point of a fortification, whether it be a wall of masonry or a bank of earth, the defenders behind a parapet cannot see, and therefore cannot fire upon, the ground close in front of the work upon which they stand. Thus, in fig. 22,* the defender of the parapet at ABC can see nothing of the space DDD at the foot of the work; and if the work be traced in a straight line, a polygon, or a convex curve, as in the figure, the ground immediately along the whole of its length—*i. e.*, the ditch, if there be one—will be unseen and undefended from the parapet; so that an enemy, having once gained the foot of the escarp, may pass freely round, and establish his mines to breach the wall, or plant his ladders to scale it, where he judges best.†

But if the continuous outline of the work be broken, so that a line (as BE, fig. 23) shall project at an angle from the general direction, AB, BC, from this projecting line the ground in front of AB can be seen and defended; and troops advancing to attack the line AB will be assailed in flank by the fire of BE. Hence, such a fire, which is the most destructive to which troops can be exposed, is called a *flank fire;* BE is called *a flank*, and is said *to flank* AB; AB, the space between two flanks, being technically called the curtain. Suppose, then, a fortress to be enclosed by a polygonal line of works, having at each angle of the polygon such flanks looking either way, the two flanks at each angle will enclose between them a square tower BEFG.*

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* Plate II.

† So, "14th May 1837, we advanced on the fortified town of Irun, a mile from the frontier of France. Exposed to a heavy fire from the batteries, our regiment darted forward and got *under the walls of the fort*, where we lay all the afternoon and night, the cannon in the fort thundering over our heads on our forces at a distance, we ready there to rush in when a breach was made."—*Autobiography of a Working Man*, (who served in the British Legion.)

So also at the attack of the great redoubt at Toulon, in 1793, the ditches being unflanked, the French storming party, driven into them twice, re-formed there with little molestation, and at the third attempt they succeeded in carrying the work.

At the attack of the redoubt San Fernando at Lerida by the army of Arragon under Suchet in 1810, the French storming party were unable to mount the escarp of the work; but as the garrison was unprovided with grenades, and the ditch was not flanked, they remained there in security. At last, as neither party could touch the other, though at such close quarters, they came to a sort of armistice and parley, which resulted in the French being allowed to go back again unmolested.—Suchet's *Memoirs*, i. 128.

If, now, the enemy attempts the attack of a curtain, as FC in plan, fig. 24, he is, during the whole of his advance, under the fire of one or both the flanks AK, HC. Driven back, he returns to the assault, but this time attacks the tower instead of the curtain. As soon as he reaches GE, the front of the tower, he is safe ;—he is unassailable, being invisible from any part of the parapet. There the ancient leader would establish his battering-ram, or roll up his moving turrets, from which he boarded the ramparts as frigate boards frigate ;—the modern would drive his mining galleries, or plant his ladders for escalade. And this fact of the towers being the weakest points of the outline, is consistent with what we know of the especial pains which the ancients took to strengthen such towers. As most liable to attack, they were made much loftier than the curtain walls,† and they were usually crowned with projecting balconies, called in medieval language *machicoulis*, from which missiles could be shot vertically down on the heads of besiegers.

Now, imagine the front GE of the tower to be broken into two faces, forming a salient angle GPE, as in fig. 25. The case is now changed. The ground at P is no longer hidden from the fire of the parapet; it is completely swept by the fire of two flanks, CH, AK.

Such an angular tower or projection, modified by experience, is a leading feature in modern fortification. It is called a BASTION.‡ BE, FG are called the *flanks*, GP, PE the

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* Such a square tower may be seen on the remaining part of the old city wall which runs along the lane called the Vennel, in Edinburgh.

† Thus Diodorus, when he ascribes a height of 100 feet to the walls of Nineveh, says the towers were 200 feet high.

‡ Though this step-by-step deduction of the outline of a bastion is perhaps the clearest way of illustrating the rationale of the matter to a beginner, it is to be understood that there is no historical authority for the gradual transition here laid down. Probably the construction in question was suggested by the form naturally assumed by a square tower at an acute angle of a city wall. See, for instance, the towers at the angles of the Moorish wall of Tarifa, (Pl. VIII., fig. 116,) which closely resemble Erard's right-angled bastions. See also Note I.

faces, of the bastion;* GPE the *flanked angle*, PGF the *shoulder angle*, EBA the *angle of the flank.* Adjoining bastions, which reciprocally defend each other, are called *collateral* bastions; AKQ, CHR are collateral to FGPEB. From the adjoining faces of two collateral bastions, as PE, KQ, a cross-fire may be directed on the ground before them, and each in a degree flanks the approach on the salient angle of its neighbour. The flanks, as is shown by the lines of fire, defend the faces of the collateral bastions.

FB is the *gorge* of the bastion, AM a *demigorge.*

The system embracing two half bastions and the curtain connecting them (as PEBAKQ) is called a *front of fortification.*

The lines PEA, QKB, parallel to which the fire of the flanks in defence of the faces must be directed, are called the *Lines of Defence;* and the angles EAK, KBE, *Angles of Defence.* The following are principles *generally* to be attended to in laying out works.

I.—Whether in a system of bastions and curtains, or in the simpler flanking arrangements which are common in field fortification, *the Angles of Defence ought not to be less than right angles.* Most men's instinct will lead them to fire straight before them. Inferior troops will infallibly do so, and at night all must do so. The angle of defence may be slightly more obtuse than a right angle, if need be, but it should never be more acute, as there would be, in that case, great risk of firing on one's own friends in the adjoining salient, instead of in their defence.

It is an elementary maxim in war, grounded on manifest reasons, that our front should be always towards the enemy. When we arrange defensive works, so that one line shall flank or sweep the ground in front of another, on one line or both we of necessity violate this maxim by turning the flank, be it of our troops or of our battery, to the enemy—so becoming exposed to a fire which shall sweep our line from end to end. Such a fire is called *Enfilade.* It may be imagined that the adjoining parapets will protect the lines of a work from enfilade—in fig. 25, for instance, that the parapets of PG, PE, will protect GF, EB, and each other, from enfilade. They do indeed, in ordinary circumstances, protect these lines from the observation of the enemy, but they do not protect them from his artillery. Guns planted accurately on the prolongation of the principal lines of a work, loaded with small charges and fired at a low angle, (6° to 9°,) pitch shot and shells so as just to clear the parapet, and to bound along the rampart beyond, carrying destruction among the troops and guns thereon posted.* This is called enfilade by *Ricochet.* It is, therefore, an important maxim, that

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* Fig. 25.

II.—*The principal lines of defensive works should, as far as is practicable, be so directed that it shall be impossible to enfilade them.* This object will be wholly or partially attained when the prolongations of the lines fall upon marshes, valleys much below the level of the works, bare rock where the construction of batteries would be difficult, &c.

III.—A third rule for the trace of works, requires merely to be stated. It is, that *the distance of flanks from the salient angle which they defend should be less than the range of their fire, so that this shall tell on an enemy with effect before he reaches the angle.*

The distance which the garrison have to traverse in shifting their defence from one point to another, should be less than that which the assailants have to traverse in changing their point of attack. Otherwise, every part of a work under siege would have to be kept at every moment manned for any emergency—a state of things opposed to the definition of fortification as the art of economising force in war, and to the third essential condition of fortification which has been laid down, viz., the advantage of position. Hence,

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* "On inspecting the defences [at San Sebastian] it was found that the tremendous enfilade fire on the high curtain, though only maintained for twenty minutes, had dismounted every gun but two. Many of these pieces had their muzzles shot away, and the artillerymen lay mutilated at their stations. Further, the stone parapets were much damaged, the cheeks of the embrasures knocked off, and the terreplein cut up and thickly strewed with headless bodies. In short, the whole land front had, from the effects of the cannonade, been rendered a scene of destruction, devastation, and ruin."—Jones's *Sieges*, vol. ii.

This, however, appears to have been immediate enfilade, not by ricochet.

IV.—*The general outline of defensive works should be a line convex towards the enemy.* So that, in any change of the point of collision, the assailants shall have to traverse a curve, of which the defenders traverse only the chord.

Again, it is of importance that all the points of a work should not be of the same constructive strength; indeed, it is scarcely in the nature of things that they should be. No work, perhaps, as a whole is impregnable; some portions, probably, of every important fortress are so. Certain points in every fortification there will be which an enemy will mark as the most assailable, and one or more of them, therefore, as the chosen points of his attack. It is most desirable that these points should be few, so that, knowing where to anticipate attack, our special measures of resistance may be disposed beforehand. Now, as a general rule, the salients are the weakest points. Prominent towards the enemy, he can advance upon them comparatively free from flank fire; whilst they are altogether without direct defence, and depend for their security on the fire of distant works. Hence results another principle, that

V.—*Salients should be few and decided.* These two latter principles, having no connection with the range of fire-arms, as the three first rules have, are applicable to all defensive systems—to the operations of armies, or the position of a series of fortresses for the protection of a frontier, as much as to the trace of field-works for the defence of a single position.

One fault inherent in the system of flanking defence that has been noticed, is the liability of flanks to enfilade. Another is, that dependence on the energies and vigilance of third parties, for our own security, is necessarily unsatisfactory.* Indeed, those troops must not only be almost perfect, but must have confidence in each other's perfection, which can efficiently carry out the system of flanking defence, requiring, as it does, each man in the moment of danger to forget himself, and to look only to the protection of his neighbour. We have just remarked this entire dependence on flanking defence as one of the weaknesses of salients; and the more acute the salient is, the greater will be the space dependent on flank fire, or, where flanks are wanting, devoid of defence altogether. The uncertainty of defence oblique to the parapet has already been noticed (Rule I.) Hence, we may consider as dependent altogether on flanking fire the angular space before the salient, included between two lines drawn at that point perpendicular to the two parapets or faces. Now, in fig. 32,* let S and T be two salient angles, S having 45° of opening and T 90°. Draw S *a*, S *b*, T *a'*, T *b'* perpendicular to the faces forming the salients. Then, as the sum of the angles round a point is 360°, we have in the one case the angular space *a* S *b* = 360° —(90° + 45 + 90) = 135°, devoid of direct fire from the parapets; in the other case the space *a'* T *b'* = 360° — (3 × 90°) = 90° only.

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* "I caused our men to retire, and to bring away with them the ladders that were whole, with no great harm to our men, by reason the enemy, being diverted by the false alarms, did not flank us."—*Commentaries of Sir Francis Vere*, p. 14.

This illustrates one reason against making salients very acute. Another is the contracted interior space which they allow for troops and artillery; and a third is the weakness of parapets drawn out into long sharp angles, rendering them liable not only to easy destruction from hostile shot, but also to speedy dilapidation from the weather. Experience, then, has fixed as a rule, that

VI.—*No salient should have less than* 60° *of opening.*†

To insure the first essential of fortification, it is desirable that not only so much of a work as lies immediately in rear of the parapet, but the whole of the interior space also, should be screened from view of an enemy standing on any point within range of fire. Hence, if works exist, or must of necessity be constructed, on sites looked into from adjoining ground, it is necessary to remedy this evil as far as may be, by giving additional height to the parapets on that side; by the erection of earthen screens in the interior of the work; by taking heed that none of the long faces are seen in the direction of their length, which would give great advantage to an assailant's enfilade fire, &c. These arrangements constitute the art of *defilade.*[*] Of course, where strong reasons do not fetter the choice of site, it is desirable that works should be constructed where they are not commanded, and do not require laborious arrangements for defilade, generally inconvenient, and often very imperfect in their result.

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* Plate III.

† As to the stringency of such rules, see the remarks in the last paragraph of the Chapter. In the common plans of Antwerp, a lunette constructed by Carnot, and bearing his name, has a salient apparently not exceeding 45° in opening. For this violation of a principle *generally* applicable, doubtless that eminent engineer had sufficient grounds in the requirements of the case, though these are not very clear from an inspection of the ordinary plans of the city.

Again, it is plain that the third essential of fortification (Chap. I.) will be wanting, if any cover, natural or artificial, is afforded to an enemy within range of fire of the works. If a work therefore be placed on a hill, its outline should follow that of the crest of the hill, so that, as far as possible, every part of the slope shall be exposed to its fire. There are, indeed, exceptions to this. When, for instance, the hill is very steep, exceeding 40° of inclination, but not inaccessible, it will be well to preserve a considerable interval between the parapet and the crest of the declivity.[†] For, practically, a discharge of musketry cannot be kept up at an angle of so great depression, so that the steep could not be defended efficiently, and, as it is accessible, any works near its crest would be liable to capture by a *coup-de-main.* If, however, in such a case, the horizontal contour of the hill admit well of a flanking fire being brought to bear from certain points on the crest of the declivity, breastworks (as *a a a*) may be thrown up on those points to cover out-posts for its defence.

All buildings, fences, trees, brushwood, &c., within range, unless they have been turned to account as part of the defensive system, should be swept away, and, if there be time, petty inequalities of ground, likely to serve as cover to an assailant, should be levelled. Where there is a system of several works, the exterior lines, which are likely to be first captured, (as *a a a*, *b*, fig. 33,)[‡] should be under the command of those within, and should be so constructed, that neither their parapets nor their ditches shall afford to an enemy who has carried them cover from the fire of the inner works.

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[*] See note at the end of the Chapter.

[†] Plate III. fig. 33.

[‡] Plate III.

Another general maxim, then, may embrace both the points on which we have now touched,—

VII.—*A defensive work, as far as possible, should view every spot of ground within range of fire, but should be seen into from none.*

Heights, as sites for works of defence, have considerable advantages in the command of observation which they bestow, especially in a country covered with brushwood or intersected by ravines, as well as in facilities for affording cover and inaccessibility.* But the popular opinion, which vaguely attributes greater strength for active defence to very elevated works, is, to a great extent, mistaken. "At the siege of Toulon, one morning Cartaux sent for the commandant of artillery, (N. Buonaparte,) to tell him he had just discovered a position from which a battery of six to twelve pieces would infallibly carry Toulon. It was a little hillock which would command three or four forts and several points of the town. He was enraged at the refusal of Buonaparte, who told him that, if the battery could command every point, it followed that every point would be able to bear upon it; the twelve guns would have one hundred and fifty to oppose, and that simple subtraction would show him his disadvantage."† Fire directed from a height on a plain below, or plunging fire, as it is called, is far less destructive than that which sweeps the surface in the whole course of its flight, and perhaps rebounds or ricochets for many hundred yards after first touching ground. The effect of plunging fire also during the night is most uncertain.‡

The rules which have been exhibited are the main general principles to be attended to in designing works of fortification; but it will often be found that all cannot be observed; that in following one we shall be compelled to violate another; or that something of each must be sacrificed. In fortification, as in all other works of engineering, we are constantly called on to hit the happy mean between opposite defects. A deep ditch is a formidable obstacle; but if we dig too deep, our ditch will be invisible from our ramparts, and our elaborate flanks useless. A high wall is hard to scale; but if we build too high, our masonry will be visible, and liable to be breached from a distance, bringing down the parapet with it, and exposing the interior of our works. Powerful and well-arranged outworks are serious obstacles to an assailant, sweeping the path by which he would advance on our bastions, and hindering his progress till he shall have mastered one after the other. But if they be too large, too numerous, or too far advanced, they make large drafts on our garrison to man them, and communication with them during a siege becomes difficult. A wet ditch is no easy matter for a besieger to cross, but neither is it easy for the garrison to keep up communication with their outworks, when the bridges have been a few days exposed to shot and shell. Nor is it inspiriting for the defenders of an outwork, which must eventually fall, to know that, when the time comes, their retreat is cut off by two fathoms of water.

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* "I directed the Nuwab's troops to occupy some high ground on the right of our line, which not only afforded them the advantage of cover, but enabled their guns to fire from a considerable elevation down into the plain. This was a matter of no small importance in a country abounding in brushwood, behind which the enemy were seen with difficulty."—*Lieut. Lake's Report of the Battle with Moolraj,* July 1, 1848.

† *Las Cases.* September 1815.

‡ "Where cannon were perched, like to scarts or sea-gulls, on the top of a rock, he had ever observed that they astonished more by their noise than they dismayed by the skaith or damage which they occasioned."—*Sir Dugald Dalgetty.*

NOTE ON DEFILADE.

The command of one work over another has been defined to be the amount by which the height of the one *above the plane of site* exceeds that of the other. The plane of site is not necessarily horizontal, and the relative command of two works, or of one work and a spot of ground exterior to it, may be exactly the same whether they be on the same level or not, provided both continue on the same plane of site.

For elucidation of this, imagine a field-work or a model of one (W) (fig. 26, Plate II.) to be placed on a table, and its command to be such that an eye (E) six inches above the table is just on a level with the crest of the parapet: it is evident that this eye would see no part of the interior of the field-work. Now, suppose the table to be canted up at one end, and the eye to retain its relative position, still six inches from the table, (fig. 27.) The eye is now at a much greater *elevation* than the field-work; but has it acquired any command over it? By no means. Let (W), instead of a model on a table, be a work on the slope of a hill, and (E) the position of an enemy on the upper part of the slope, the relative command and advantage of position is exactly as it was on the horizontal plane.

It is true that, if the projectile energies of the enemy at (E) were to be expended in rolling "huge round stones resulting with a bound" down upon the work, the force of gravity would give him an advantage; but in the discharge of fire-arms within reasonable range, the difference of effect between firing up-hill and down-hill can hardly be appreciable.

Again: if the work (W) retain its horizontal position whilst the position (E) is elevated, (as in fig. 28,) it is plain that the latter will see the interior of three sides out of four. Whilst the base of the work remains as before, let us next elevate its parapets towards (E), until their crest occupies the position shown in (fig. 29.) The work is then screened from the observation of (E); it is *defiladed* from that eminence.

Observe that in raising the parapet towards (E), you necessarily raise the banquette with it, and thus bring the defenders standing on the banquette into view from any point on the horizontal plane beyond (F), where it is intersected by the crest of the parapet produced. Now, if this intersection be within range of fire of the work, further steps must be taken to defilade the work on the side of the plane also. This would be accomplished by assuming a point (F″) on the plane beyond the range of fire, and raising the whole parapet, till the crest lies in a plane passing through (E) and (F″). (Fig. 30.)

But as this would, in every case where the command of (E) is considerable, involve an extravagant elevation of the earthwork, it becomes necessary to defilade the two halves independently of each other, interposing a traverse or isolated screen in the middle of the work, which protects the parapet towards (E) from being taken in reverse from the plane, and the parapet towards (F) from being taken in reverse from the hill. (Fig. 31.)

The same principle will apply where the work has to be defiladed from an eminence on the side of (F) as well as (E).

When the work (W) is a lunette, or other work open at the gorge, it must be supposed to be supported from the side of (F), and its defilade, therefore, need only regard the hill in front.

Where such a work is commanded from two eminences not in the same horizontal line, (or, more correctly, not subtending the same angle of elevation from the site of the work,) each half may have its plane of defilade directed on the eminence which adjoins it, and be protected from the reverse or oblique fire of the other eminence by an arrangement of traverses either perpendicular to its face, or stretching along the capital of the salient.

As the number of commanding eminences round a work increases, defilade becomes very difficult, and can only be a slight palliative of a faulty position. For a cumbrous reduplication of traverses in such a case, might perhaps be substituted an inner continuous retrenchment, following the general outline of the exterior work.

It would not suit the plan of this work to follow this subject further. Enough, perhaps, has been said to give a definite idea of the objects and methods of Defilade. For simplicity's sake, we have considered the plane of defilade as tangent to the eminence which commands the work. Strictly speaking, it must be considered as passing at a height above the eminence equal to that of artillery above the ground, or of musketry, or of a hostile parapet, as the case may be. When annoyance from musketry only is looked for, heights at a greater distance than 350 yards need not be regarded. With respect to artillery, 1200 yards is the limit usually assigned.

CHAPTER III.

OBSTACLES, MATERIALS, AND OTHER ACCESSARIES OF FORTIFICATION.

"Hostibus insidior; fossas munimine cingo."——OVID, MET. xiii.

Before entering on an explanation of the outlines and combinations of works, we proceed to describe various obstacles applicable as auxiliary to the defence, especially in field-fortification, and various materials and other accessaries of engineering utility.

OBSTACLES.

1. *Abattis.*—An abattis consists of trees cut down and laid with their branches towards the enemy. If the trunks be heavy, and the branches well sharpened and entangled together, it is a very formidable obstacle. Lighter trees should be bound together, and well fastened down by strong stakes.*

Abattis are placed sometimes all round a work, sometimes at the salients, or at the gorge of works having no parapet in rear. They may lie at the foot of the glacis, or at the bottom of the ditch, or lean against the counterscarp; they may be employed to close highways and defiles, &c. They should, like all such obstacles, be within easy range of fire from the work which they protect; so that the enemy, when grappling with the obstruction, or brought up by it, shall be fully exposed to the shot of the defenders. If the abattis be exposed to artillery fire, it will be well to throw up a small glacis to cover it.† "Heavy trees, with the trunk half cut through, form insurmountable obstacles. This is called an *entanglement.*"‡ (*Aide Memoire.*) Fir-trees make bad abattis, on account of the brittleness and formality of the branches.

2. *Palisades*, or strong palings, if used, should be made so strong, and fixed so firmly, that they shall be really a serious obstacle. They may be made of the rough stems of young trees, or of the halves and quarters of larger trunks. When deliberately made by carpenters, they are usually of a triangular section, having each side 7 to 9 inches; they stand 9 feet above the ground, and should not be more than 5″ or 6″ apart. The foot of the palisades should be sunk 3 to 5 feet in the earth, and there fastened to a heavy rail of timber. A lighter rail or riband binds them together just under the tops, which are pointed.§

The usual place of palisades is in the ditch pretty close to the counterscarp. They are there in the way of an enemy about to leap into the ditch, whilst, at the same time, they are covered from the shot of his artillery. "In the last campaign," however, (of the Peninsular War,) " the palisades of the redoubts thrown up on the Montagne de la Couronne, in the Pyrenees, where wood was plentiful and cost nothing, were made of trunks of trees, placed close together at the foot of the escarp, and were found almost equal to a masonry revetment."—(*Sir J. Jones.*) This, perhaps, should be called a stockade, rather than a palisade. *

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* Plate III., figs. 34, 35.

† Fig. 34.

‡ Fig. 36.

§ Figs. 34, 35, 37.

Palisades are sometimes fixed in an inclined or nearly horizontal position, into the slope of the escarp or counterscarp. They are then termed *Fraises.* The best place for them is about 2 feet under the crest of the counterscarp.† Fraises, in that situation, are little likely to be injured by a front fire of cannon or howitzers, and the manual operation of cutting them away is extremely difficult, besides that the men so employed are exposed to the fire from the parapet of the work.—(*Sir J. Jones.*) In the escarp they are more liable to destruction, undefended from the parapet unless the ditch be flanked, and if once mastered they form something of an aid to the assailant in mounting the exterior slope.

When palisading is not merely an accessary, but forms the principal defence of a post, the work is generally called a *Stockade.* In such a case the timbers are usually placed in close contact, loopholes and embrasures being cut in them for musketry and artillery fire. The earth from the ditch, if there be one, may be thrown up outside the timber, to form a parapet as high as the loopholes; or, instead of cutting loopholes in the wood, the trees of which the stockade is formed may be planted a few inches apart, and the intervals filled as high as the loopholes with smaller trees. In the Burmese campaigns of 1825-26, works of this nature were of such constant recurrence, that the war might be considered mainly a war of stockades.‡ The *Pahs* or stockades of the New Zealanders are generally situated on elevated peninsular points, so as to be on three sides unassailable, except by surprise. The fourth side has a deep ditch, crowned by a palisade of large trees planted 7 or 8 feet apart, the intervals filled up with stakes or poles 8 or 10 feet high, strongly bound to one another and to the palisades. In some the larger trees are almost in contact, and a thick screen of the New Zealand flax plant bound to the outside. This is tough enough to resist a distant musket-shot. The loopholes are on the ground-level, deep trenches for cover being dug inside the stockade. The interior of the work is intersected in every direction by palisades and excavations. The ditches are also frequently flanked by a strong palisade.

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* Fig. 35.

† Fig. 37.

‡ See NOTE B, *Burmese Stockades.*

The *Palankas* of the Turks on the Hungarian frontier were a species of permanent intrenched camp attached to fortresses, in which the ramparts were revetted with huge beams rising 7 or 8 feet above the earth-work, so as to form a strong palisade above.

A small Λ-shaped stockade is frequently used in the defence of buildings and villages, to give a flanking musketry fire, to cover gateways and bridges, &c. In such a position it is called a *tambour*.

3. *Chevaux-de-Frise.*—A *cheval-de-frise* consists of a substantial piece of timber called the barrel, pierced through its scantling in alternate directions, and having long stakes or spears of ash, or other tough wood, fixed in the holes at mid-length, so as to present four or more points radiating outwards. The spears should be too closely serried for a man to get between them. Chevaux-de-frise of iron have been introduced, in which both barrel and spears are hollow. The smaller tubes pack away in the barrel for transport, and, when used, their ends are plugged with spear-heads.*

Chevaux-de-frise are sometimes placed in the ditches, or at the gorge of open works. If suitable trees are to be had, abattis is a better obstacle. But it may be that trees, which would make very bad abattis, may cut up into good chevaux-de-frise or palisades.

A row of chevaux-de-frise, made of well-tempered sword-blades, was placed by the French on the summit of the breach at Badajos, and it was an obstacle which the assailants were unable to remove or surmount.

When the cheval de-frise is used as a barrier to close the entrance to a field-work, one end will turn on a pivot, and the other traverse on a small wheel. Gates of various other forms are also used as barriers.

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* *Aide Memoire.*

4. *Trous-de-loups*, or pitfalls, along the foot of the glacis, are a common and good auxiliary obstacle. They are funnel-shaped, with sharp stakes in the bottom of each, and in the intervals. Their depth, if greater than 2′ or 2′ 6″, should be not less than 7′ or 8′, in order that they may not be taken advantage of as cover for the enemy's marksmen. The earth taken out may form an advanced glacis to conceal the holes.*

5. *Pickets*, or stakes of different sizes, driven hard into the ground, within a few inches of each other, and having their heads pointed with a drawing-knife, are very destructive to the order of an attacking party. They should project above ground 9″ to 30″. Pickets of pointed bamboo, hardened in the fire, were placed in front of some of the Burmese stockades. They gave great wounds when run against, and sometimes occasioned loss of limbs.† Those four-pointed implements called *calthrops* or crow's-feet, which Bruce is said to have strewed on his flank at Bannockburn, have still a place in the magazine of the Field-Engineer. The slopes of the field-work called the Turkish Wall, at Aden, used to be set with broken glass—no despicable obstacle to a barefooted enemy. Harrows, with the frame buried and the spikes protruding, serve the same purpose ; or, if the ground naturally abounds in brushwood, the stems, as they stand, may be cut to various lengths and pointed, the bare spaces being filled up with pickets and harrow-spikes. In works sufficiently permanent in their object to allow a year or two of preparation, the glacis may be purposely planted with brushwood, to be cut in good time, when attack is anticipated. Not only are its pointed stems an obstacle to the advance of troops, but its roots add greatly to the difficulty of excavating works of attack. Tropical climates afford many thorny plants, which make most formidable fences, such as the various kinds of cactus and euphorbia.‡ It has been suggested that a line of forest trees

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* Plate III. fig. 37.

† Major Straith's Fortification.

‡ "A large redoubt was thrown up on the sandhills between Fort Puntales

should be planted on all the slopes of permanent works.* A row, planted pretty closely along the interior slope of the parapet, would afford a skeleton for a formidable stockade, the intervals of which would be filled up with the timbers cut from the other rows. These latter would also be available for abattis at the breach, stockaded retrenchments, splinter-proof cover, palisades, and other purposes of defence; whilst the roots, binding the soil, would render sapping the glacis, or effectually breaching the rampart, alike difficult. With such an object I believe that the glacis and esplanade of some of the new German fortresses have been thickly planted.†

6. *Inundation.*—Should a stream run past or through the work, the construction of a dam across it, or a cut from its bed, may, in many sites, afford aid to the defence, by flooding the ground before a part of the works. Inundation has been considered as of two kinds, *parallel* and *perpendicular.* The first, where the inundation is parallel to the line of the defences, is merely an obstacle. It adds greatly to the inacces-

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and the city of Cadiz; from the moving nature of the sand, it was impossible to keep anything like a ditch which should present an impediment to the advance of an enemy. Advantage was taken of several hedges formed of aloes; these were carefully transplanted into the ditch, and, placing them five or six rows deep, they took root, and soon presented such a formidable obstacle, that it was almost impossible to pass them; and from being a very weak work it became one of a very respectable character."—Lt.-Col. H. D. Jones in *Engr. Papers,* iii. 94.

* By Colonel Hamilton Smith, *Aide Memoire,* vol. ii.—" Defensive Elements." A similar recommendation is made by Maggi, one of the old Italian writers, and by the oldest French author on fortification, Erard de Bar-le-Duc, book i. chap. vi.; as also by Noizet de St Paul, in his *Traité Complet.* The last author's proposal was followed up by a general order from the Committee of Fortifications, (1795.)—See *Aide Memoire,* i. 257.

A quickset hedge was a common defence in the Dutch fortresses. " The ditch was hemb'd in on the brink of the water-stank with a strong double hedge of thorns, that secure the walls from any sudden swimming or assault."—Lithgow's *Experimental Discourse, &c., of the last Siege of Breda,* 1637.

† " At the attack of Badajos, the stump of a very large tree, which had been cut down about two years, was found whilst breaking ground to occupy the centre of the parallel; and its roots spread so much, and were so difficult to clear away, that it required a second night's work to render this point of the same breadth and depth as the other portions of the parallel."—Jones's *Sieges,* i. p. 368, note.

sibility of a place; indeed, if neither to be forded nor turned, it effectually excludes that part of the line which it covers from being considered as assailable by a rapid movement at all.* It is therefore well suited as an aid to a weak garrison. Where continuous, however, around a great part of the work, it confines the defenders within their lines, preventing their taking advantage of any opportunity for acting on the offensive. And should the dam or cut be at a distance from the place, provision must be made for its independent defence. Wet ditches are inundations of this description. Capture of the source of supply, before it had been taken advantage of to fill the ditch, was the first step in the celebrated siege of Bhurtpoor in 1826; and at Mooltan, in 1848, the British dammed off the canals from the Chenab, by means of which it was understood that Moolraj had the power of inundating the ground round the fortress. Marshy ground skirting the works, and traversed by narrow causeways, on which the means of defence may be concentrated, is a favourable form of this defence. In cases, however, where a post is to be long held on the defensive, the risk of malaria from the inundated ground destroying the health of the garrison may be so great as to render this mode of defence objectionable.

Perpendicular inundation is formed when the stream runs from the country towards the place.† The dam may then be within or immediately under the defences. The lake formed in this case has its length extended in a direction perpendicular, or nearly so, to the trace of the work. If extensive, it may seriously weaken the operations of an investing force, by rendering his communications circuitous; and it thus gives great advantage to offensive movements by the garrison. So when a fortress is situated on the fork of two confluent rivers —like Coblentz between the Rhine and Moselle, or Passau between the Inn and the Danube, or Belgrade, or Komorn, or Allahabad—the investing army must be divided into three corps, and must have three bridges to maintain their communications. An example of perpendicular inundation may be seen in the plan of the siege of Ath, (Pl. VII., fig. 105.)

* Fig. 38. † Fig. 39.

In climates subject to hard frost, the inundation or wet ditch ceases in winter to be an obstacle, and in fact becomes a help to assailants.* In field defences, it will rarely be practicable to keep the ice broken. But the frost may be enlisted in aid of the defence also, by sprinkling the outer slopes of the parapet with water, until covered with a sheet of ice. This will render them almost unassailable by *vive force.*

Where inundation is not of itself deep enough entirely to obstruct an enemy's movements, deep holes may be prepared under the water at irregular intervals.

Dams to form inundations may be made, where wood abounds, of whole timbers built in cross tiers, and sheeted with plank in front and rear; of fascines;† of wooden cribs, or gabions,‡ filled with stones and heavy rubbish, and *puddled* over—*i. e.*, covered with a thick coat of clay; or of clay alone. Where the dam is of earth, and no better material is at hand, it may be lined with mats or thatched hurdles. A substantial bridge may be readily turned into a dam, by laying timbers across from pier to pier, on the up-stream side, or otherwise blocking up the waterway of the arches.

7. *Scarps.*—Where the works or posts are on hilly ground, the natural slopes, in suitable situations, may be cut down perpendicularly, or nearly so, presenting an inaccessible cliff. This is called *Scarping.* Scarps were extensively employed in the lines before Lisbon in 1810-11. "The chief difficulty," says Sir John Jones, "in tracing a line to be scarped, was to find portions of the ascent sufficiently steep, that, when cut to the required angle, the base should not

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* As at Bergen-op-Zoom, 8th March 1814, when the Guards escaladed the Orange Bastion, crossing the frozen ditch, and planting their ladders on the ice. "After having thoroughly considered and discussed the matter, I decide on having the ditches without water. They are best and safest so; for we have seen in our time how the freezing of wet ditches in winter facilitates the assault of a town, and endangers its capture. So it fell out at Mirandola, when Pope Julius laid siege to it."—Machiavelli, *Art of War,* vii. 1.

Among the unprecedented feats which marked the early years of the Revolutionary wars was the capture of the Dutch fleet at the Texel by a body of cavalry and horse-artillery, which galloped across the frozen Zuyder Zee.—See Alison, ch. xvi.

† See p. 34. ‡ See p. 33.

form a road, which might serve as a breathing and rallying point, and, unless flanked, a secure communication to an assailant. . . . . It never was presumed that scarps could be trusted to without defenders; but it was considered a great point gained to have rendered portions of ground of such difficult access as to be safely left to the guard of a small corps, or to unsteady troops, such as the militia on the lines."—(*R. E. Papers*, vol. iii.)

8. *Fougasses*, or small mines, are a very efficient aid to the defence of important field-works. It has often been remarked that there is no peril in war which so much impresses the imagination, and which troops are so unwilling to encounter, as that hidden danger of mines.* " At the storming of Badajos, the troops under Major-General Walker, after performing prodigies of valour in escalading a wall 31 feet in height, whilst pursuing their vanquished antagonists round the ramparts, were opposed by a single field-piece placed on the terre-pleine. On the approach of the British, the gunner lighted a portfire, which threw out a sudden blaze. A man among the foremost of the pursuers called out, 'A mine!' The word was re-echoed through the ranks, caused a panic, and the whole of these brave fellows immediately dispersed,—such as could find a hole or corner, creeping into it."—(Jones's *Sieges*, i. p. 468.) So at the attack of Tournay (1709), " the soldiers entertained a great and almost superstitious dread of the perils of that subterranean warfare where courage was unavailing, and the bravest, equally with the most pusillanimous, were liable to be at any moment blown into the air, or smothered underground, by the explosions of an unseen, and therefore appalling enemy."—(Alison's *Marlborough*, p. 257.)

The charge of powder for a fougass is buried in a chest, near the foot of the glacis, in the ditch, or other place that may be judged best. The mine is fired by a *hose*,—*i. e.*, a tube of linen cloth filled with powder, enclosed in an *auget* or square wooden pipe, which is conducted under ground into the ditch, or, if necessary, into the interior of the work. The box and the auget should be well pitched to keep damp out, and the site of the mine should be disguised. It will be well to place the fougass in immediate proximity with abattis or some similar obstacle, which shall detain the assailant on the spot, so that the explosion may not fail of its object.

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* ————————" I brave each combatant
Whom I can look on, fixing eye to eye,
Who, full himself of courage, kindles courage
In me too. 'Tis a foe invisible
The which I fear.——
Not that which, full of life, instinct with power,
Makes known its present being."
Death of Wallenstein, i. 5.

Fougasses may also be formed by burying shells in sets of three or four, or large shells singly. For this purpose,

The 8″ shell should be placed 3′ deep.
10″ ... ... 5′ ...
13″ ... ... 6′ ...

When shells are used, they are placed fuze downwards in a box resting on a horizontal shelf or partition, with perforations through which the fuzes of the shells communicate with the powder in the lower part of the box. This is sometimes a charge sufficient to cast the shells to the surface before they burst.

The French at Badajos appear to have laid a *chaplet* or continuous train of 14″ shells along the counterscarp of the breached front.*

Stone fougasses are formed by digging a funnel or embrasure-like excavation, opening obliquely upwards to the front.† The charge is placed at the bottom of the funnel; over it a lid or frame, strongly planked, and the remainder of the excavation is loaded with stones or bricks.

At Gibraltar, in 1782, when the besiegers were endeavouring to mine the then unflanked face of the cliff under Willis's Battery, mines, or *chances*, as they were called, were sprung from the top of the rock as the parties got nearly under it; the stones from which caused them considerable loss.‡

Fire as well as water has been used as an auxiliary obstacle to protect a wide and practicable breach. During the siege of Turin, in 1706, a narrator of the defence says,—"We had just reason to fear that the enemy would attack us again with greater force and vigour. To put ourselves in readiness to receive them, we brought together a vast quantity of faggots, billets, and such kind of stuff, which we piled up in the breaches of the ditch. Fire being set to these things, we continued to supply them with flax steeped in oil and flaming gaudrons. The enemy, seeing themselves separated from us by an ocean of fire, were strangely surprised at so terrible a stratagem." And this was repeated night after night.—(*Military History of Eugene and Marlborough*, i. 238.)

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* Order by Colonel Lamarre, chief engineer of the garrison, quoted in Jones's *Sieges*, i. 456.

† Plate III. fig. 40.

‡ Drinkwater, chap. viii. See Note C, at the end of this book.

Bonfires on the breach are also recommended by Vauban, in his instructions for the defence of Quesnoi and Verdun.*

MATERIALS.

It is next necessary to notice several descriptions of materials used in field-fortification.

1st, *Gabions.*—These are cylindrical baskets, without top or bottom, used to form field-revetments.† They are usually from 2′ 9″ to 3′ high, from 20″ to 24″ in diameter, and weigh 25 to 40 pounds. The speediest mode of obtaining artificial cover from the musketry-fire of a work, is to dig a trench, and fill, with the earth taken from it, a row of these baskets placed on end immediately in front of the excavation. The art of approaching a fortress by such trenches is called *sapping*, and the trench itself a *sap*. When liable to fire on one side only, it is called a *single sap;* if exposed to fire on both sides, and therefore covered on both sides by gabions, it is a *double sap*. Whether the sap be double, advancing directly on a work, or single, advancing obliquely, it is necessary to protect the head of it by some cover, readily movable as the work proceeds. For this purpose, large double gabions are used, each consisting of two concentric baskets, having the interval between them packed with stout sticks.‡ This, laid on its side, forms a great musket-proof roller, called a *sap-roller*, which is readily moved on as the trench advances. The usual size is 6′ by 4′, with 9″ interval between the two gabions. It has been found that, by giving the sap-roller a slight *bulge* in the middle, like that of a barrel, it is much more readily turned when the sap is required to form an angle.

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* Allent, *Hist. du Corps du Genie.*

† Figs. 41, 44, 45, 48.

‡ Fig. 42.

2d, *Fascines* are faggots of brushwood.* To make them conveniently, form trestles by driving pairs of stakes into the ground—St Andrew's cross-wise—at about 3′ interval; lay the twigs and rods on the trestles till there are enough of them for a faggot of the thickness required; press or *choke* them hard together, and bind them at intervals with withes or string. The choking is accomplished with a tool which consists of a piece of chain joining two hand-spikes. The chain is cast round the faggot, and two men, by bearing on the hand-spikes, choke it hard, whilst a third binds. The *choker* is then transferred to another place for another binder, and so to the end of the fascine for every 12 or 18 inches of its length. Fascines are used in revetting parapets and embrasures; † in forming dams, and filling wet ditches; to give a platform for works or roads in marsh or heavy sand, &c. Thus, at the great battle of Blenheim, fascines were used by the Allies to enable them to cross the marshy rivulets which ran in front of the French position. And, in the attack of Acre by Buonaparte, in 1799, "the grenadiers moved forward from the trenches, but were stopped very soon by a wide and deep ditch with a revetted counterscarp. This obstacle, however, was soon surmounted. Fascines were thrown into the ditch, the ladders placed on them, and the troops descending, moved forward to assault," &c. ‡ For a similar purpose, Marlborough, when marching to surprise Villeroy's lines between the Meuse and Antwerp, made each trooper carry a truss of hay at his saddle-bow.—(Alison's *Marlborough*, p. 124.)

3d, *Hurdles* were much used by the ancients in their field-works, and are still occasionally found serviceable for revetting, or for laying on wet ground alternately with beds of fascines. Layers of hurdles, covered with heath and ballast, were extensively used by Stephenson in the sub-structure of the Liverpool and Manchester Railway, where it crosses Chat Moss. In the trenches at Antwerp, deluged with incessant rain, the French laid double tiers of fascines, and over these a layer of strong hurdles, for the passage of artillery.—(*U. S. Journal* for 1833, p. 360.)

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* Fig. 43.

† Figs. 46, 47, 48, 49, 50.

‡ Article on Acre, in *R. E. Papers*, vol. vi. 28.

Hurdles for portability may be made 6′ long by 2′ 9″ broad. Such a hurdle weighs about 50 pounds when dry.

Revetments may be made in hurdle-work, by driving stout stakes along the face of the slope to be revetted, to a depth of about 2 feet in the ground at its base. Branches are then woven in and out between these stakes, and vertical binders applied when the wattling is completed. Similar wattlework is employed in Flanders for revetting the submerged escarps of wet ditches.

4th, *Sandbags* are made of canvass, in the British service, usually 2′ 8″ long by 1′ 3″ wide. They are most useful as a portable material, with which to construct a parapet or traverse in ground where excavation is difficult or undesirable; for the construction of loopholes on the top of a parapet;* for *tamping* or packing mines after they are charged; and for revetments in soil so loose that it would run through wickerwork.† If used, however, to line an embrasure or barbette, raw hides should cover the sand-bags, as they will be very apt to take fire from the discharge of the guns. Even fascines and gabions are liable to this accident in a dry climate. At Mooltan, in 1849, an experimental battery was formed by building up the solid portion entirely of fascines 9′ long. Four officers of engineers and two Sepoy sappers erected a two-gun portion in little more than half-an-hour, the material being close at hand. But the day after it was armed, the battery caught fire from the explosion of a shell from the citadel, and was entirely consumed.‡ At the British attack on the Havanna, in 1762, a fire broke out among the dry fascines and gabions, with which the besiegers' works were formed, and continued to burn for two days, till the whole of the parapets were destroyed.

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* Fig. 52.

† Figs. 51, 52.

‡ The late Major Siddons's Journal of the Siege, in the *R. E. Corps Papers*, vol. i. 437.

A filled sand-bag of the dimensions given is about 6″ thick when built into a parapet, and weighs about 60 lb.

Besides the materials we have described, there are others used in the revetments of field-works. Woolpacks seem to have been a regular article of field equipment for forming lodgments, in the Continental wars during the time of Louis XIV. They were used abundantly in the attack of Edinburgh Castle, when held by the Duke of Gordon, after the Revolution in 1688.* And at the attack of Fort Christoval, opposite Badajos, in June 1811, woolpacks were employed to form the parapet of a battery on hard rock. This parapet was found throughout the siege to resist the shot, (at 450 yards from the place,) and preserve its shape remarkably well.† At Bhurtpoor, in 1825, parapets of cotton bales were found, at 800 or 900 yards from the fort, to resist every species of ordnance discharged against them—even an English 18 lb. shot, though the ball penetrated and rolled out harmless on the other side. But in the more advanced trenches, they proved of very little value.‡

Sods, cut of a regular oblong form, built up in alternate layers of headers and stretchers, like bricks in a wall, make the best-looking, and probably the best of all revetments. Sods should be laid perpendicularly to the face of the slope, with the grass downwards. That the turf may bind well in with the earth of the parapet, both parts of the work should advance together. The interior slope of parapets should be revetted from the natural ground upwards, not from the newly-raised earth of the banquette.

In a dry climate, an excellent revetment may be made of earth wetted as for brick-making; or the whole parapet may be so constructed as in the celebrated mud-forts of India. If time serves, for the higher class of field-works, *pisé* may be used—*i. e.*, earth built up in successive masses, which are rammed hard in movable frames of strong plank, till a consistency is attained, incredible to those who have not witnessed it.* In Upper India, and many other hot countries, fragments of the mouldering mud-walls, which abound, afford a ready and good material for revetments.

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* Grant's *Memorials of Edinburgh Castle.*

† Jones's *Sieges*, i. p. 49.

‡ Captain Boileau's *Journal of the Siege.*

For escarps in loose soil it is usual to describe elaborate revetments of carpentry. But such work, on a great scale, is unsuitable to the circumstances of field-fortification, and its use must be very rare. If wood is abundant, it will be best applied in forming a detached escarp, such as that described by Sir J. Jones in a passage quoted above, (p.25.)

ACCESSARIES.

A few other accessaries of fortification in general remain to be described.

Traverses are detached lengths of parapet, constructed within a work,—

1*st*, To bar the effects of enfilade fire.

2*d*, To diminish the destructive effect of bursting shells by intercepting their splinters.

3*d*, To screen the interior of the defences from a commanding eminence.

Or, 4*th*, To masque an opening left in a parapet for communication with the exterior.

Where the traverse is intended merely to intercept splinters, the face to which it is attached not being liable to enfilade, it need only be made of splinter-proof thickness, or from 2′ to 5′ at top. Such a traverse may readily be constructed of sandbags, or of a double tier of gabions.† Its length will be 18 or 20 feet, sufficient to cover the gunners and guns in battery. It will be made of the same height as the parapet, and may be either attached to it, or separated from it by a space sufficient for communication.

Traverses on lines liable to enfilade should of course be shot-proof. It is usual to construct them between every two or three guns, on the faces of permanent works, as soon as a siege is apprehended. 12 feet at top is a usual thickness for such traverses.

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* The walls of Moorish fortifications in Spain, such as the Alhambra and the castle at Gibraltar, appear to be composed of a sort of *pisé* of clay and gravel.—Murphy's *Mahomedan Empire in Spain,* 287. *R. E. Papers,* vol. iii. p. 92.

† Figs. 45 and 48.

The height of a traverse intended to screen the interior of a work will depend on the relative height and position of the ground from which the work is to be defiladed.

A traverse to mask an opening in a parapet is usually made inside, and parallel to the direction of the parapet. It should be long enough entirely to hide the interior from direct or oblique observation through the passage; and, being liable to be battered by the same metal as the parapet, it should be of the same thickness. A traverse adapted to these conditions will in small works be found to occupy a most inconvenient amount of room. Where the entrance to a field-work can be conveniently covered by being placed in a re-entering angle, or by one part of the parapet overlapping the other, (as in the field-work, fig. 63,) this is to be preferred.*

Musket and splinter-proof traverses might be compactly constructed of a single row of large gabions, like sap-rollers; of deal boxes filled with earth; or of masses of *pisé*.

Traverses for defilade, though perhaps occupying an inconvenient amount of interior space, may often prove of good service in prolonging the defence of a field-work. At the siege of Toulon, the British garrison of the fort called Little Gibraltar, by their obstinate defence of the interior traverses, caused great loss to the assailants, and long prevented their mastering the work.†

Traverses may also be turned to account, by forming them with hollow cells, or galleries lined with timber, to serve as magazines for ammunition. And the larger traverses have sometimes afforded space within their mass for the construction of splinter-proof accommodation for the repose of a part of the garrison.

A magazine may readily be obtained in the space formed by pieces of stout timber leaning at an angle against a wall or the interior slope of a parapet, and having the sloping surface covered with a foot or two of earth. Where timber is

* Plate IV.

† Dufour, *Mémorial pour les Travaux de Guerre.*

not to be had, ammunition-boxes may be turned into magazines by burying them in the end of a traverse or the interior of a parapet, the box being made to stand on end, so that its lid opens like a door.

Detached magazines are also often constructed of splinter-proof frames and planking prepared for the purpose; protected, when set up, by a thick covering of earth.*

Guns repeatedly discharged from the same ground, in order to their being fired with celerity and accuracy, and that they may be easily run forward after recoil, must be placed on a solid and smooth platform. In permanent fortifications this is frequently of masonry; in field-works it must be of timber. Fig. 53 shows the old pattern of platform, whether of timber or masonry. Fig. 51 is a modern and convenient form of light field pattern. Its component parts are 5 sleepers, 15′ long, and each 5″ square; 20 planks, each 10′ 6″ long and 9″ wide; 2 ribands, each 15′ long and 4″ square. Notches are cut at the ends of the planks, admitting of the insertion of lashings, called *rack-lashings*, because attached to a short stick, by means of which they can be racked or twisted perfectly tight. The sleepers are first laid and adjusted; over these the planks; the ribands are placed like side-rails at the outer edges of the platform; and then the rack-lashings, being passed under the outside sleepers, through the notches of the planks, and over the ribands, bind all fast.

Hurter is the name applied to a piece of square timber laid at the front end of the platform, to prevent the gun wheels from running into and injuring the parapet. A fascine will serve just as well.

The platform is generally elevated 6″ in rear, to counteract the recoil of the gun.

Mortar platforms are similarly constructed, but of smaller size, (7½′ × 6½′,) of heavier scantling, generally with transverse timbers under the sleepers, and of course are laid perfectly level.

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* Plate IV., figs. 54, 55, 56.

CHAPTER IV.

VARIOUS FORMS OF FIELD-WORKS, &c.

> "I would be proud to hold some dialogue with you, Sir Duncan, on the nature of the sconce to be there constructed, and whether the angles thereof should be acute or obtuse—anent whilk I have heard the great Velt-Marescal Bannier hold a learned argument with General Tiefenbach during a still-stand of arms."——LEGEND OF MONTROSE.

THE horizontal outline of a work is called its *Trace*.

We have hitherto dealt with principles applicable to all works, or with details which may be used with works of any outline. We now proceed to point out the different traces of works, especially those used in field fortification.

In field fortification the *magistral* or tracing line, that line which is first laid down in the field or on paper, and from which the position of all the other works is determined, is the crest line of the parapet. There is good reason for this. It is the length of this line which must be proportioned to the number of men who are to defend the parapet; it is the area enclosed by this line which at once determines the available interior space. In permanent fortification the *cordon*, or coping of the escarp wall, is the guide. In that case the irregularities of the ground have been in a degree obliterated; the parapet is raised upon an artificial terrace, and all the lines of its slopes are parallel. But in field-works, hurriedly executed, and often on irregular and undulating ground, the base of the exterior slope, answering to the position of the cordon, may be far from being a straight line. Thus if *a b*, *a′ b′*, *a″ b″*,* represent sections of the ground, on which the parapet is constructed on the lines A B, A′ B′, A″ B″, respectively, it is plain that, whilst the position of the crest line C C remains constant, the lower line of the exterior slope as shown at *b*, *b′*, *b″* in the section, at B, B′, B″ in the plan, waves in and out as the ground rises and falls; and to lay this down as the first or guiding line, would require complicated and tedious measurement and calculation.

The simplest trace is of course a straight line. It is used in in its simplicity in some batteries not liable to be taken in flank, and epaulements to cover reserves from artillery fire; in traverses to cover openings and defilade works; in breastworks and barricades, cutting off roads, covering piquets, &c.

Two lines or faces meeting in a salient angle form what is called a *redan*, otherwise a *flèche*, or arrowhead.†

Sometimes flanks are given to the redan, either parallel to the capital, or inclined inwards at the gorge.‡ It so assumes the form of a detached bastion, and is then termed a *lunette.* This is a common form in permanent as well as field fortification, especially for *advanced works*,—*i.e.*, works thrown out beyond the ditch, &c. of the main work, to occupy some spot of ground from which it is desirable to exclude the enemy.

* Figs. 57, 58, Pl. IV.

† Fig. 59.

‡ Fig. 60.

To keep up the communication from such works to others in rear, a trench with a parapet on each side may be constructed. This is called a *caponière.*

The gorge of the redan and lunette, though not closed by a parapet, may be protected by palisades, abattis, or other obstacles. These render the work capable of some independent defence, whilst, in the event of capture, they give the enemy no cover from the fire of works in rear. Where the latter are armed with artillery, the gorge of a lunette may be closed with a thin loop-holed wall, as this may be speedily demolished, should the work fall into the enemy's hands.

These works, and others open at the gorge, can only be used when supported from the rear, as advanced parts of a combined series of works, as cover for outposts or gateways, or for the heads of bridges, the gorge then resting on a river. The ditches of the lunette and redan are undefended, and the salients are without fire. This last defect is remedied, in some degree, by cutting off the interior angle at the salient by a straight line long enough to give space for several muskets. These works may be made of any dimensions; but as large works require large garrisons, and large garrisons should be capable of isolated defence, which these works are not adapted for, they are usually of no great size.

The *double redan* is a useful form, as its salients are defended.* The re-entering angle between the salients should be a right angle, (see p. 14.) It is a common form for a bridge-head of minor importance, or work protecting the passage of a river. In that case, the long side faces, or branches, may receive additional defence from guns on the other bank.

Either the single or double redan may have the faces broken, so as to offer short flanks for the defence of the salients.†

Another form is the *Tenaille Head.*‡ It may be adapted to some situations, but wherever a fire from the rear can be brought to flank the faces of the double redan, that construction is decidedly preferable.

The *Bastion Head* is the usual form of important bridge-heads in field defence.§ It consists of one or two fronts of

* Fig. 61. † Figs. 62, 63. ‡ Fig. 64. § Fig. 65.

fortification defended by bastions, and having the branches or lateral faces flanked by batteries or other works in rear. The single front (as in fig. 33) is called a *Hornwork*, and the double front (fig. 65) *a Crownwork;* and under these names they are frequently attached as advanced works to permanent fortresses.

These, or modifications of these, are the usual forms of *open* works,—*i.e.*, works open at the gorge.

Closed Works.—These may have the faces flanked or unflanked. Small closed works with unflanked faces are termed *Redoubts ;* large and important closed works, usually having flanks, are termed technically *Forts.*

The oldest form of redoubt is probably the circular. Such are most of the old British or Danish field-works, which may still be traced on so many sites in our country, under the local nomenclature of Duns, Tors, Raths, or Chesters; whilst, what the language of our art terms *permanent works*—the walls and towers which, in ages far more recent, were built around our cities—have with few exceptions vanished, leaving no vestige. This work affords, according to a well-known property of the circle, more internal space than any work of the same extent of outline, and presents little opportunity for enfilade. It is objected to as being equally assailable at all points, as not being suited to irregular ground, as not admitting flank defence to its ditches, and as being difficult to execute. It has been very rarely used in modern war. A small circular redoubt of casks was constructed by the British Engineers to support the trenches of attack on the isthmus at San Sebastian;* and an example is given in the *Aide-Memoire* (vol. ii. Pl. 10) of a round redoubt with flêches as outworks, which was thrown up by the French on the banks of the Zezere in Portugal. Small permanent forts of masonry have frequently been constructed of a circular form, especially for coast defences.

The *square redoubt* is very common. The main objection to it is the large angular space at each salient without direct fire, and its thus presenting so many as four prominently assailable points, requiring perhaps to be defended simultaneously, whilst they afford each other no aid. The redoubt should not be less than 20 yards square, on the crest line, and usually does not exceed 40.

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* Jones's *Sieges*, vol. ii. Plate XI.

On irregular sites, the trace of a redoubt must be accommodated to the form of the ground, which usually requires that it be broken into sides and angles following the crest of the slope, if on a height, and that its sides be so traced as to parry fire from neighbouring heights. Such redoubts are termed *Polygonal.* They may be regular polygons, but are generally quite irregular. The greater the number of sides, the more nearly the polygon approaches to the circular trace in merits and defects. Fig. 66 represents such a redoubt, which was one of those in the celebrated Lisbon lines.

Several methods are practised to obviate the defects of redoubts, and other works having undefended salients and ditches.

To defend the salient—

1*st*, The crest of the parapet at the salient may be rounded,* or cut off by a line perpendicular to the capital, so as to give some musketry fire direct on the ground before the salient.

2*d*, The parapet for a space near the salient has been sometimes broken into *cremaillère*, or zigzag, by short lines alternately perpendicular to the capital and parallel to it.† This may be considered one of those elaborate attempts at minute perfection which look well on paper, but are most troublesome to execute, and, after all, in practice fail to prolong the defence. Sir John Jones remarks—" This mode of indenting the parapet was not thought a good measure generally, it being found to add very much to the labour, and to abstract from the direct fire of the work an equal quantity to that it threw in a different direction, besides making the defence of the parapet rather complex for militia. Therefore latterly, in those works where any particular trace was not imperious, it was always preferred to make an additional face to the work rather than to leave a salient angle so acute as to necessitate such extra support; and at Almada this principle was carried so far as to render the contour of some of the redoubts almost circular."*

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* This rounding of the salients is a characteristic feature of the Roman legionary intrenchments. In old castles we sometimes find a loophole on the salient angle, or others at the side obliquing towards it. See Noltland Castle, in Billings' *Bar. Antiq. of Scotland,* i.

† Fig. 67.

3d, Where the redoubt is to be armed with artillery, the guns will usually be placed in barbette at the angles; or, if there be any special reason for employing the embrasure, it may be traced with its line of fire on the capital.

For the defence of ditches in works without flanks, there are several expedients:—

1st, Grenades should be supplied abundantly, to be pitched over the parapet when the assailants have descended into the ditch, and are about to make their rush, or, having failed, are collecting and rallying there. Shells, masses of stone, and round timbers, also may be placed on the top of the parapet, ready to roll down. Scripture tells how Abimelech was slain under the tower of Thebez by a piece of a millstone cast by a certain woman; Plutarch, how the same fate befell Pyrrhus, king of Epire, at Argos; and in modern times, at the escalade of the Castle of Badajos, says Alison, "logs of wood and shells thrown over, crushed and tore in pieces whole companies at once."† Similar expedients may be employed to defend the face of a steep hill. At Bunker's Hill the Americans prepared casks filled with stones, and chained in pairs, to roll down upon their assailants.

2d, In a work assailable only on the salient, such as a lunette or redan, having its gorge and flanks completely defended from the rear, loopholed stockades may be run across the ditch, from behind which a musketry fire can be brought on the ditches before the faces. Ramps from the gorge will communicate with the ditch in rear of the stockade; or the stockade may encircle the work a few feet from the foot of the escarp.

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* Memoranda relating to various details of field-works thrown up at Lisbon, *R. E. Prof. Papers*, vol. iii.

† "Sir Francis Vere, flourishing his sword, called to them, in Spanish and and Italian, *Vienneza!* causing the soldiers, as they climbed up, to tumble down among them the firkins of ashes, the barrels of frize-ruyters, the hoops, stones, and brickbats which were provided for them."—*Siege of Ostend,* (App. to *Vere's Comm.*)

3d, If the work be assailable on all sides, a timber gallery may be run athwart the ditch from the escarp, and may either abut on the counterscarp, (in which case its roof may serve as a bridge), or may be separated from it by widening the ditch at that part. This work is called a *Covered Caponière*, being roofed over with splinter-proof timbers. It is loopholed on both sides, so as to give a fire sweeping the ditch on either hand. Its site will be either at the salient angle, or in the middle of a face of the work. Sometimes a small ditch is dug along the foot of the timber walls, to prevent the enemy from firing through the loopholes or grappling with the defenders' muskets. Should the caponière be used as a barrack, which it sometimes is, the ditch should be dispensed with, as it would retain stagnant water.

4th, A gallery may be excavated in the counterscarp, embracing two sides of a salient for a space equal to the breadth of the ditch, so as to afford a fire from its loopholes to sweep the ditch before both faces. In ordinary soil the gallery must be lined, and the roof supported by timber. In stiff soil, or soft rock, where this gallery can be constructed without support, it will be preferable to the caponière. Fig. 68* is an example from a redoubt near Oeyras, in the Lisbon lines. Communication will be kept up with the caponière, and usually with the gallery also, by means of passages under the parapet.

Abundant provision must be made for the ventilation of the two works last described, by cutting holes near the roof.

It is plain that both these works, being of tedious and expensive construction, are suited only to the higher class of field-works referred to at page 3.

Field-Forts.—This name is technically applied to closed works of a larger and more important kind, such as require garrisons of 200 to 500 men.

As the construction of these greater works generally implies that the position which they occupy is of great value, the outline should be so traced as to give efficient flanking defence to the salient angles, and, as far as possible, to the ditches. Any attempt to do this in small works is futile, because the re-entering angles, which are produced by breaking the contour into lines flanking one another, whilst they increase the length of parapet to be defended, vastly diminish the interior space available for the accommodation of the defenders. In such a work, if the salients are few, they must be excessively acute; and if they be many, the flanks become so short as scarcely to exceed the breadth of the slopes of the faces which they are meant to defend. Thus,* let a circle of 50 yards diameter represent the extent of ground to be occupied by a redoubt; inscribe a square in it; the side of this square will be about 36 yards. Now, with an idea of giving a flanking defence to the salients of this redoubt, let us break each of its faces into a re-entering angle. Observe the result: the interior space is almost annihilated, and the weakness of the construction is manifest from inspection. Again:† suppose an octagon instead of a square to be inscribed in the given circle; here the interior space, though much cut up, is not so absurdly contracted as in the last instance; but the expected flanking defence turns out to be very small. The length of the flank, clear of the thickness of the adjoining parapet, is only 4 or 5 yards, affording an oblique fire of as many muskets on the capital of the adjoining salient; and on a more contracted area there might scarcely be room for one or two muskets. Such works are termed *star-forts*.

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* Plate IV.

On a large area, say of 120 yards diameter, the objections we have pointed out are far less applicable.‡ The irregularity of ground, however, would generally render the construction of a regular *star-fort* of such a size unsuitable, nor would it be desirable to offer so many points liable to attack. But a similar disposition of alternate salient and re-entering angles, on an irregular figure adapted to the natural features of the ground, is very common in works of this description. Bastions also, or demi-bastions, may be used in combination with such faces, in suitable positions. See for example (fig. 73) one of the greater works at Torres Vedras.

The construction of a regular fort with bastions and demi-bastions is shown in fig. 72. The demi-bastion, though it does not give so efficient a flanking defence as the bastion, affords more interior space, and will sometimes be more eligible. Thus in fig. 72, though the long branch A F is not so situated as efficiently to flank the face E B, yet it is itself more efficiently defended by E F than if it had been broken into face, flank, and curtain. Hence, if the face and flank F E B be covered by inundation or precipice, so as to be unassailable, the demi-bastion construction is to be preferred; and it always has the advantage of giving more space.

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* Plate V. fig. 70.

† Fig. 70*.

‡ Fig. 71.

With regard to flanks defended by artillery, " it ought to be received as a general rule that no flank can be formidable to infantry which does not contain at least three pieces of ordnance; and even to render a flank of three pieces very destructive, it must be in a situation of tedious approach, or in a work which cannot be run into."*

It is to be observed that the re-entering angles of works traced like star-forts are always *dead angles*—*i. e.*, are necessarily unseen and undefended from the parapet. And so also will be the curtain angles of the bastioned fronts, if the *exterior side*, or distance between the salients of the bastions, be not of a certain length. For, suppose the smallest suitable relief of a work to be r, and the superior slope of its parapet to incline 1 foot in 6, it is manifest that the nearest part of the bottom of the ditch, which can be seen and defended by a flank, will be 6 times r distant from the parapet of that flank. Hence if the curtain, or whole length between two flanks, be not more than 6 times r, the angles of the curtain will be dead angles. And if *half* the length between the two flanks be less than 6 times r, then some portion of the ditch before the middle of the curtain will be unseen and undefended from either flank.

Now, in field-works, which usually cover a small area, and are dependent for their defence on small arms, it is often impracticable to give such extent to the exterior side as shall prevent the existence of dead angles even in a bastion tracing.

Hence timber galleries, with loopholes for the defence of the ditches, will be most desirable in works of importance, even though provided with flanking parapets. These galleries may be constructed either in the counterscarp of the salients, or under the parapet of the flanks.

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* *Memoranda on the Lines*, &c. by Sir John Jones.

Further provision for prolonging the defence may be made by cutting off the weakest and most accessible points of the outline by a secondary parapet and ditch, so that the fall of the point assailed shall not involve that of the rest of the work. Such a work is called a *Retrenchment.* And in all important positions there should be a *keep*, or inner place of strength, as a rallying post and place of final defence. An existing strong building may be made the nucleus of a field-fort, and formed into a keep for it. In Portugal the windmills, which abound, were often turned to account as interior posts of this kind.

If there be no such convenient building, but timber is to be had, a *Blockhouse* may be constructed for interior defence. This is a covered work principally made of wood. Square timbers of not less than 9″ scantling planted upright, side by side, form the walls. A cap or wall-plate runs along the top of these, on which strong beams rest at intervals. These beams are overlaid with a roof of fascines, or planks, covered with 2 or 3 feet of earth. The walls are loopholed, and the soldiers' wooden cots are so placed as to serve for a banquette. A ditch surrounds the work, the earth from which is thrown up against the walls to the height of the loopholes. The spaces between the beams are left open for ventilation; the entrance is by a bridge of light plank, which can be drawn into the work. Should there be any mound or height existing in the interior of the work, the blockhouse may be planted on it. In this case, instead of making a ditch, the sides of the mound will be scarped, and the foot protected by a palisade.

Where time and material are not scanty, and an artillery fire is expected, the work may be constructed more strongly. The walls in this case will be double, filled in between with well-rammed earth. A small earthen parapet may likewise be constructed on the roof. This will afford a protected place for cooking, and for breathing fresh air to the garrison cooped up in narrow quarters. It also affords a watch-tower on which to post a sentry, and adds something to the defence. Such a roof is made thick enough to resist small shells, and must be supported by strong posts within.

Where time or means are deficient, an earthen parapet may first be thrown up. In contact with the interior slope strong posts are planted at intervals, rising 7″ or 8″ over the crest. At this height wall-plates are laid from post to post, and, over these, beams, fascines and earth as first described. The interior slope is revetted, and the space between the crest of the parapet and the wall-plate serves instead of loopholes for the musketry of the defenders.*

In plan, a blockhouse may be made a simple rectangle, or, in a larger space, may have the form of a cross. It may occupy a flanked salient of the fort, and in that case it will take the form of the exterior work. In a fort with a large garrison, several such interior works will have to be provided, in order that there shall be room in them for the whole, or nearly the whole, force.

A blockhouse may be made two stories high, in which case the upper story will project over the lower, so as to present a balcony or machicoulis, through which a fire can be directed downwards.

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* Dufour.

CHAPTER V.

CALCULATIONS, &c., NECESSARY IN THE ACTUAL CONSTRUCTION OF WORKS.

"Souldiers ought to know, that when occasion requireth them to intrench themselves, it doth as properly belong to their duty to intrench themselves as to stand centry or to carry their arms."——Monk's (Duke of Albemarle) Observations on Military and Political Affairs.

"It is as much a soldier's duty on service before an enemy to work as to fight."——General Order by Sir T. Graham (Lord Lynedoch) at Cadiz, in 1810.

WHEN a field-work has to be actually constructed, the first step is to design the outline of the work and the profile of the parapet. Technically the mass of earth excavated is called *deblai*; the mass piled up in parapets, &c., *remblai*.

The capacity of the ditch will depend on the amount of earth required for the parapet, and this ought to be calculated beforehand. If the depth of the ditch be first fixed, as may often be necessary on account of the occurrence of rock or water near the surface, the breadth will have to be adjusted to the content of the parapet. If the breadth be assumed, the depth must be adjusted. Let the depth be assumed, and the area of a profile of the parapet be calculated. Were the parapet a line with no prominent curves or angles, no calculation would be necessary further than to divide the area of the profile by the depth of the ditch, in order to obtain the mean width of the latter. But it is obvious that excavation so calculated would, at a salient angle, afford a great surplus of earth, and at a re-entering angle earth would be deficient. Perfect accuracy is not sought, and where equal salient and re-entering angles occur alternately, as in a star-fort, the surplus and deficiency may be considered to balance one another. But, in a square or polygonal redoubt without re-entering angles, or in a bastioned fort, where the salients greatly preponderate, the excess of excavation, when ditch and parapet are of equal profile, will be very great, and consequently the section of the ditch must be reduced.

In a regular figure, the difference may be calculated for one angle or front; and by ascertaining what proportion the excess of excavation bears to the whole cubic content of the ditch on the corresponding side or front, the necessary reduction in the width of the ditch may be estimated. But in an irregular figure, every subdivision of the work would require a separate calculation, which would be very tedious. The following is the accurate way of solving the problem.*

The cubic content of any figure of uniform profile is equal to the area of the profile multiplied by the length of the path of its centre of gravity. Now, the path of the centre of gravity of the profiles of the parapet will, in a convex figure, be shorter than that of the profiles of the ditch; in a concave figure, it will be longer. Hence, in the former case, the profile of the ditch must be correspondingly diminished; in the latter, increased. When the position of the centres has been ascertained, the whole content of the parapet may be determined by one calculation. But in every case of important irregularities, such as large ramps and traverses, barbette batteries, &c , separate calculations will have to be made of the excavation necessary.*

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* Major Straith's *Fortification*, chap. ii.

All the dimensions having been fixed, the work will then be traced on the ground. The principal salient angles will first be laid down, and the crest of the parapet marked out. If the ground be tolerably level, the lines of the other slopes may be laid out parallel to the crest line. Profiles of lath or posts connected by cord will then be set up on the capitals, and perpendicular to the faces. The excavation will then be commenced. Where the ground is irregular, the base lines of the exterior and interior slopes will not be parallel to the crest, and they will be most easily determined by setting up two profiles with the lines representing those slopes, inclined at the proper angles. The base lines may then be fixed by bringing the eye into the plane of the two profiles, and marking where this plane intersects the ground.

Where time presses, it will be sufficient at first to mark out the position of the interior crest line, and of the middle of the ditch. Whilst the excavation is proceeding within safe limits, the profiles can be set up, and the other parts of the trace completed, before the nicer adjustments come to be required.

Before entering on the execution of a work, it will of course

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* The profile of any parapet may be divided into rectangles and triangles. The centre of gravity of any triangle is the intersection of two lines drawn from any two of the angles to the middle points of the opposite sides. The centre of gravity of a rectangle is the intersection of its diagonals. The distance of the centre of gravity of any aggregate system of bodies from a given plane is equal to the sum of the products of the content of each body, multiplied by the distance of its centre from the plane, divided by the sum of the contents of the bodies. Hence in the figure (74,) if the profile be divided into triangles and rectangles, of which the centres are found to be *a b c d* respectively, and *g* be supposed to be the centre of the aggregate profile, and perpendiculars be let fall from all these centres to A B C D G on the horizontal line P Q, then

$$\text{PG}=\frac{\text{PA} \times \text{triang. } a + \text{PB} \times \text{rectang. } b + \text{PC} \times \text{triang. } c + \text{PD} \times \text{triang. } d}{\text{triang. } a + \text{rect. } b + \text{triang. } c + \text{triang. } d},$$

which enables us to determine the horizontal position of the centre of gravity *g*, and so to ascertain the length of its path on the plan of the work.

be necessary to calculate the number of labourers required to complete it in the allotted time. Without here entering into any minute detail, it is sufficient to say that, in easy soil, 1 cubic yard, or 27 feet, per hour of work in excavation is as much as can be calculated on. Where the work is a simple breast-work thrown up from an interior trench, the men may be placed at 6 feet apart, and complete the work themselves. Where a regular parapet, with banquette, &c., has to be formed, two-thirds as many men may be added for this work. If the ditch be wide enough, a double row of diggers may be placed in it, with two-thirds of the whole number added to work in forming the parapets, &c.

The extent of parapet in a work must be proportioned to the number of men and guns available for its defence. In a long line, or work open at the gorge, it will be sufficient to reckon a man per linear yard of parapet for a single rank of defenders, and two men per yard for a double rank, to which it is well to add one-third more as a reserve.

In a closed work, where there is a likelihood of the garrison being shut up, possibly for several days, reference must be had, in allotting the strength of the force, to the interior area available for the accommodation of the men, as well as to the length of parapet.

20 square feet per man within the banquette should be allowed. Field-pieces mounted may be considered to occupy each 6 linear yards of parapet, and 300 square feet of internal area.

Hence, every calculation of internal dimensions for a work of this kind will require some mutual adjustment of the numbers, that these conditions may be met.

For instance, we wish to ascertain the size of a square redoubt to contain a garrison of 200 men and 2 guns. Suppose the men to be placed in a double rank with 60 in reserve. Then—

$200 - 60 = 140$, the number of men manning the parapet.

$\frac{140}{2} = 70$, the number of files ... ...

70 files require 70 yards of parapet.

2 guns ... 12 ... ...

Length of parapet, = 82,

which divided by 4, gives 20½—(say 21)—yards for the side of the redoubt. But as the side of the area inside the banquette will be at least 5 yards less than this, say 16 yards.

An area 16 yards square, contains 16 × 16 × 9 = 2304 square feet.

But we require for 200 men 4,000 square feet.
... ... 2 guns 600 ...

In all, 4,600 square feet.

Hence the redoubt cannot, on the given conditions, contain its own garrison.

Again, suppose we have the men in 2 ranks, but no reserve:
100 files manning the parapet require 100 yards.
2 guns ... ... 12 ...

112 yards

$\frac{112}{4} = 28$ yards the side of the redoubt, or 23 within the banquette; 23 × 23 × 9 = 4761 square feet internal area, which will now accommodate the garrison and guns, with 161 feet to spare.

But suppose the reserve of nearly ⅓ to be a *sine quâ non*, let us try what figures will answer the conditions of area and linear extent of parapet. Try a garrison of 400 with a reserve of 130—

$\frac{400 - 130}{2} = 135.$ $\frac{135 + 12}{4} - 5 = 31\frac{3}{4}$, say 32 yards, the side of the redoubt within the banquette.

32 × 32 × 9 = 9216 square feet, the internal area.
Now 400 men require 8000 square feet;
And 2 guns ... 600 ...

8600

Hence the area is needlessly great by 616 square feet.

A garrison of 390 men, in a double rank, with a reserve of 130, and 2 guns, will nearly reconcile the conditions, giving 35½ yards for the side of the redoubt.

CHAPTER VI.

LINES, OR EXTENDED SYSTEMS OF WORKS.

> ——————— "We will erect
> Walls and a Ravelin, that may safe our Fleet and us protect.
> And in them let us fashion Gates, solid and barred about,
> Through which our Horse and Chariots may well get in and out.
> Without all let us dig a Dyke, so deep it may avail
> Our Forces 'gainst their charge of Horse and Foot that come to assail;
> And thus the attempt that I see swell in Troy's proud breast shall fail."
>
> ILIAD, vii. (Chapman.)

WE have now briefly described the principal forms of works in outline and profile; the apparatus of auxiliary obstacles and most useful materials of defence; the methods and calculations necessary for laying down works in the field. These methods and apparatus it is for the engineer to apply separately, or combine in the manner most suited to the place and occasion.

The name of *Lines* is applied to any extended or combined series of field-works. They are usually classed as *continuous lines*, and *lines at intervals*.

The construction of continuous lines of great extent is a very ancient practice. Cæsar mentions such works repeatedly. Before his time, existed an instance of continuous lines stretching for 1500 miles; an instance remaining to this day—

> ———" that mighty wall, not fabulous,
> China's stupendous mound."

Parallel with the Edinburgh and Glasgow Railway may still be traced the lines which the legions of Antoninus constructed to protect his British province against the indomitable barbarians of the Grampian hills. It was a general practice in ancient times to construct a double line round a besieged fortress—one of *contravallation*, to shut in the garrison; the other of *circumvallation*, to shut out relief. This continued to be customary in the last century. Such were the lines round Platæa, mentioned by Thucydides;* the lines round Alesia, constructed by Cæsar; the lines round Belgrade, by Prince Eugene; round Turin, by the French in 1706.

The construction of extensive lines was a favourite practice with the French leaders at the beginning of the last century. Year after year we read of intrenchments thrown up by Villeroy, or Vendôme, or Villars, extending for 30, 50, and even 70 miles; and almost as often we read of their being turned or pierced by the great leaders of the Allies. The custom of enclosing an extensive surface of country with continuous lines is now generally condemned, as a source of weakness rather than of strength. In no case where the intrenchment is intended to serve as anything more than a mere fence, a passive obstacle, perhaps connecting rivers, marshes, two fortresses, or similar existing features, behind which an inferior combatant may watch the enemy's movements with some degree of security from being committed to an engagement against his will, should the extent of parapet be greater than the force is able to man efficiently at every part. The compact rectangular camps of the Romans were peculiarly suited for defence by continuous intrenchment; but the long narrow encampments, in use since the introduction of firearms and modern tactics, are ill adapted for enclosure by a continuous enceinte. When a line is of great extent, the points liable to attack must be so numerous that we cannot select those which are likely to be assailed, so as to concentrate on them our active and passive means of defence. Thus our force is diffused and weakened. By enclosing our troops, we surrender to the enemy the *initiative*—the choice of where and when we shall engage. He can concentrate his force, though we cannot; and thus the works almost cease to deserve the name of fortification: for if we gather our strength to repel him at one or two places, he may force our line at a distant point; and such a line, once forced, is almost always lost. The continuity of the line, moreover, prevents the garrison from readily acting on the offensive when occasion serves, since their advances and retreats must be made by defiling through narrow passages, on which the enemy may concentrate his artillery,* whilst the ins and outs of the flanked trace render it necessary to man an extent of parapet nearly double the length of the front to be defended, and destroy all tactical arrangement for a forward movement, even where that may not be precluded by the obstacles in front. And the greatness of the necessary labour is itself a serious objection to such works, as well as the publicity which must attend their construction.

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* " Now the wall of the Peloponnesians was of the following construction : It consisted of two lines round the place, one against the Platæans, and another in case any one should attack them on the outside from Athens," &c.—Dale's *Thucydides*, iii. 21. The last notable instance of extensive lines of circumvallation was at Mayence, when blockaded by the French in 1795.

In 1654, when Condé, invading his country with a Spanish army, laid siege to Arras, and surrounded his investment, according to the approved fashion of the time, with a strong double circumvallation, Turenne attacked the lines, forced them at all points, and raised the siege. Shortly afterwards, Turenne himself was defeated, under exactly similar circumstances, at Valenciennes, which he had invested; but at Dunkirk, when again in the same position, he marched out of his lines and beat the Spaniards under Condé, in the celebrated battle of the Dunes.*

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* "The Prince of Orange drew off his forces to give him [Condé] battle, and to that purpose, *after the laborious work of filling up our lines of contravallation that the horse might pass more freely,* we lay upon our arms all night."—*Memoirs of Captain Carleton.*

In lines at intervals, on the other hand, all the salient and important points are occupied by works, traced so as to afford reciprocal defence, and effectually to maintain the ground over which they are scattered, but at the same time capable in some degree of independent defence; whilst the intervening spaces are available for the free movements of troops, concentrated when desirable, instead of being diffused over a long extent of parapet. In fact, after supplying the garrisons necessary for the detached field-works, which form, as it were, the bastions and outworks of such a defensive line, the remaining troops are available as curtains to connect them, with this difference, that these are movable according to need—which curtains of ditch and parapet are not. And should the enemy endeavour to carry the line at some point by surprise, yet, as each work must be separately stormed, time is afforded for the reinforcement of that point, and the recovery of such works as have been lost. The moral effect, too, of an arrangement which allows of a relief to the garrisons of the field-works, and leaves a great part of the force capable of free offensive movements, whilst always, in case of repulse, secure of a support and rallying-point, is to be highly valued.

In lines at intervals, the more advanced points will generally be occupied by redans, or other works open at the gorge. Batteries of guns in the re-entering spaces between the redans will flank the faces of the latter, and these batteries will be closely protected by redoubts and forts in the rear, on strengthening which all available resources have been expended.† The villages and strong buildings which occur on the site of a system of lines should be embraced in its trace, and strongly fortified as flanking posts—especially on the salient ridges of vours of the French under the Emperor's ablest lieutenant.* These lines were singular in the extent of ground which they embraced, and the great number of the works in proportion to the force of the army in position within them. But these exceptions to common principles were justified by the peculiarities of the case;† such were—the peninsular position of the tract defended, the one flank resting on the sea, the other on the Tagus, so that the lines could not be turned or attacked in rear, whilst the access of supplies and reinforcements by sea was secure; the "extraordinary strength given to the flanks, which rendered them rather fortresses of support than points to guard;" the projection of the rugged and (to guns) impassable ridge of Monte Junto for fifteen miles opposite the centre of the lines, which would have entailed on the assailants a very long and tedious march in order to move from one flank to the other, whereas, from the central position of the main body of the British army, a very short march would have enabled the defenders to succour either the right or the left; the celerity and accuracy with which signals could be transmitted from one end to the other. "Throughout the whole front there was not a continuity of artificial line necessitating a single efficient brigade to be kept up out of column; and the works may be regarded as so much additional strength given to the army, without subtracting a man from its effective force."‡

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* U. K. S. Gallery of Portraits—Turenne. See plans of the three battles in Ramsay's *Memoirs of Turenne.*

† See Pl. V., fig. 83.

Late instances in India, on the banks of the Sutlej, have shown how formidable a resistance may be made by aid of intrenchments of compact outline, and defended by a well-manned artillery, even when the works, as at Ferozshuhur, are trifling in themselves; and at Goojerat the severest loss of the British occurred in the capture of the villages which the Sikhs had occupied.

Suppose the passage of a river to be defended by lines. If a choice is left us for the site of the bridge, a re-entering bend of the river is the best place, both because it enables us to bring a concentrated and enfilading fire on an enemy advancing on the bridge, and because on a river running through an alluvial soil, the convex margin will almost infallibly have the highest and most commanding bank.* On the further side, covering the bridge or ford, we may construct a redan, hornwork, or crownwork, leaving ample openings for the reception of our retreating troops. The immediate head of the bridge will be covered by a stockade in the form of a redan, or double redan. Close on the near bank, batteries of simple trace flank the branches of the bridge-head, and fire into its interior and on the bridge or ford. Trenches for musketry also are carried along the edge of the bank. One or two smaller redoubts, and a large field-fort, crown the higher ground in rear, and command the interior of the other works.

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* "BEAR WITNESS, EUROPE! BEAR WITNESS, ASIA! THAT HE NEVER WENT FORTH TO BATTLE BUT HE COVERED HIS ARMS WITH GLORY. MIGHTY CAPTAIN! WHO NEVER ADVANCED BUT TO CONQUER; MIGHTIER CAPTAIN! WHO NEVER RETREATED, BUT THAT IN HIS RETREAT HE ECLIPSED THE GLORIES OF HIS VICTORIES!"—*Lord Brougham.*

† "Hoc autem genus ordinationis exsequi, nisi peritus et ad omne momentum respondens miles, vix potest."—*Frontinus,* ii. 3, sec. 7.

‡ Sir J. Jones. For a notice of Sir J. Jones, see NOTE D at the end.

If the object of the bridge-head were only to secure the retreat of an army across the river, elaborate works on the near side would be unnecessary. They will be used when the passage is one of lasting importance, of which it is desirable to maintain permanent command.

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* "The King examined every reach and turn of the river by his glass; but finding the river run a long and almost a straight course, he could find no place which he liked; but at last, turning himself north, and looking down the stream, he found that the river, fetching a long reach, and doubling short upon itself, made a round and very narrow point. 'There is a point will do our business,' says the King; 'and if the ground be good I will pass there, let Tilly do his worst.' . . . . Now the Imperialists discovered the design, but it was too late to hinder it. The musketeers in the great trench and the five batteries made such continual fire, that the other bank, which, as beforesaid, lay twelve feet below them, was too hot for the Imperialists; whereupon Tilly, to be provided for the King at his coming over, fell to work in a wood right against the point, and raised a battery for twenty pieces of cannon, with a breastwork or line, as near the river as he could, to cover his men; thinking that, when the King had built his bridge, he might easily beat it down with his cannon. But the King had doubly prevented him; first, by laying his bridge so low that none of Tilly's shot could hurt it, for the bridge lay not above half a foot above the water's edge—by which means the King, who in that showed himself an excellent engineer, had secured it from any batteries to be made within the land, and the angle of the bank secured it from the remoter batteries on the other side; and the continual fire of the cannon and small shot beat the Imperialists from their station just against it, they having no works to cover them."—Passage of the Lech by Gustavus Adolphus, in Defoe's *Memoirs of a Cavalier.*

The achievement of which the above, though narrated by a fictitious character, appears to be a lively and correct account, was one of the most masterly enterprises ever executed. Here fell brave old Tilly, the Blucher of the seventeenth century, and the survivor of fifty campaigns and six-and-thirty victories.

Though we have given sufficient reason why the construction of continuous lines as the whole or main part of a large system of defence is unadvisable, yet there are cases where it may be desirable to trace and execute continuous works of very considerable length. Such a line, for example, may be wanted to bar the passage of convoys through a particular line of country, or to exclude from it small parties, or bodies of horse, attempting inroads to forage, plunder, and ravage the district. Or, it may form a necessary part of a large system of detached works, especially when, from natural and artificial obstacles, access is so difficult, that it can be safely left to the guard of a small or inferior body of troops. Or, with troops numerous, but of indifferent quality, and ill suited for offensive action, it may be advisable to form lines almost continuous, in order to give them confidence to maintain their ground at all. Or, a line of some extent may be formed to cover a communication between two otherwise detached works.

In the first case, the simplest trace will be best—a line broken at considerable intervals by redans.* These are the guard posts, and afford some flank fire. Where an attempt to force the line is probable, the redans may be brought closer together, or the curtain between every two redans may be broken into a salient angle, (figs. 76, 77.) The last is preferable, as presenting two instead of three points of attack in the same extent of front. The *tenaille* trace (fig. 78) offers salients all equally assailable, but they are at nearly as great distances as the points of attack in the last case.

The *indented line*, (fig. 79 and 80,) consisting of alternate long faces and short flanks, at right or slightly obtuse angles with each other, is an excellent trace for a long curtain or communication between two flanking works. In such a case it may be formed as a trench with the earth thrown outwards, a construction involving little labour, and no obstruction to offensive movements on the part of the defenders. In continuous portions of an important series of lines, a bastion trace may be adopted.*

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* Plate V., fig. 75.

Where the general outline of a system of lines is polygonal, the defence of the grand salient at the angle of the polygon must be specially cared for. Besides bringing as much flanking defence on it as possible from works on the right and left, the salient may be broken into a re-entering angle or tenaille, with flanks; or, if it be of consequence to occupy the angle itself, that may be done by a flêche or lunette, flanked by a front of fortification in its rear.

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* Figs. 81, 82.

CHAPTER VII.

DEFENCE OF POSTS AND VILLAGES.

> ——————"Tibi dextera bello
> Utilis; ingenium est quod eget moderamine nostri."
>
> OVID, Met. xiii.

WHAT has hitherto been said has been of the creation of obstacles and defences, rather than of the improvement of such as chance affords. But, though perhaps instruction in principles may be best derived from the study of the former branch of the subject, it is in the practice of the latter that the field-engineer may most frequently have to apply his principles. And not the professional engineer only. To him, it is true, will be generally confided the design and construction of systematic works. But any infantry officer may be called upon to maintain an outpost, a garden, a village, or group of buildings, and may fail lamentably from mere want of knowledge how to improve and turn to account the capacities of his position for defence.

The possession of this knowledge, and readiness to apply it, may enable an officer commanding a small detachment, with a little preparation, to repel a far superior force, or to maintain his ground, when his doing so is of the greatest moment to the success of the army to which he belongs. And this not in defensive fighting only. "During the progress of an attack, there frequently occur points which it is of the last importance to maintain when gained. Villages and groups of houses may become points of support for prosecuting an attack to a successful issue, if rapidly secured and barricaded; or, they may save an attacking army from defeat; and sometimes it becomes of great consequence to troops who have taken a barricaded village, to know how to render the defences useless, or to reverse them."*

If there is a choice of buildings to be occupied and defended, the main points which guide the selection will be substantial structure, commanding situation, capability of affording flanking fire and materials useful for defence, facility of rendering access difficult whilst affording ready means of retreat for its occupants, (should retreat not be absolutely excluded from consideration by the circumstances,) and, of course, size, with reference to the garrison which is to occupy it. It is also to be considered whether the post is altogether isolated, and liable to attack on any side, or forms a member of a system of defence protected in rear and flanks by other works, or by the troops which it assists to cover. In the latter case, attention would be entirely given to strengthening the front open to attack, leaving free communication with the rear.

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* Colonel Reid in the *R. E. Professional Papers*, vol. ii.

All fences encircling the house, and not intended to be defended, or whatever else may give cover to an enemy, should be cleared away, and all thatch or similar readily combustible substances destroyed.

If we have force enough to garrison outhouses, and are likely to have time to render them a part of our post, they will be left, otherwise they must also be swept away. Loopholes must be broken through the walls at every three feet, especially in positions flanking the doors, and points most liable to attack. A double row of loopholes may often be had, if we pierce one row near the ground-level, to be used by men standing in a trench dug inside the wall; another at a height of some seven feet, to be reached from a banquette of planks laid on casks, trestles, or pillars of dry stone or brick.* The loopholes are pierced from the inside, so that the outer orifice is most contracted. If the walls are thick, it will be difficult to make loopholes; if time serves, however, they may be opened by piercing from outside and inside simultaneously. Ditches should be dug outside a loopholed wall to prevent grappling. Where an outside wall does not exceed 6′ high, the upper row of loopholes had best be cut down like notches from the top, and crossed above with sandbags or trunks of trees.

Doors and windows on the ground-floor will be strongly barricaded and loopholed. Windows on the upper floors should be built up man's height with bricks, timber, sandbags, &c., leaving loopholes.

A free communication round the defences must be formed by breaking through the partition walls, where doors do not exist.

Materials should be ready to barricade the staircases; and the upper floors may be pierced for musketry, so as to prolong the defence when the door is forced. Water should be provided on every floor, to extinguish fire.†

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* Plate VI., fig. 95.

† In Charles XII.'s desperate defence of his house at Bender against the Turks, (1713,) when the latter, after losing upwards of two hundred men, succeeded in setting fire to the building by means of arrows bearing lighted

Outside, all the approaches to the house will be crossed by barricades, whether of ditch and parapet, or of palisades strengthened in front by abattis, trapholes, &c., or by the latter alone, under a fire from the building and out-offices. By help of fences, outhouses, &c., an outer continuous line may be thus formed and defended where the garrison is sufficient to man it. Fences so retained for exterior defence had better always have abattis or trous-de-loup outside, to prevent their being turned to the advantage of the enemy.

Any balconies existing may be turned to good use as machicoulis, from which to fire down on the assailants. Where there are none, and time can be spared, it may be worth while to construct them of timber over the doors, and other points most liable to attack.

Where the form of the building affords no flanking defence, small stockades or tambours may be thrown out from the walls to flank them. These may be made covering a door or window, and so communicating with the interior; otherwise, communications must be broken in the walls. If at the angles of a building, these tambours may be in the form of a bastion, or of a quadrant. Midway in the face of a wall, they will take the form of a redan.

An officer having the duty assigned him of strengthening such a post, would first set his men to work on indispensable preparations, such as cutting trees near the house for abattis, collecting carts, harrows, and the like, suitable as obstructions, in the places where they would manifestly be required, filling sandbags, or gathering in the house other materials for barricades. Whilst these works were going on, he would have time to methodise his ideas of the details necessary.

2. In defending a village the practice will be similar. Fences parallel to the circuit of the village will be removed. Those perpendicular to it will be retained as obstructions to the free movements and communications of assailants. All

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matches, the King, by help of two of his men, laid hold of a cask of liquid which was standing by, and dashed it over the flames; but unfortunately the cask was filled with brandy!—VOLTAIRE.

the external approaches from which the enemy can advance will be barricaded. Where the continuity of the defences is kept up by houses and garden walls, these will be loopholed, ditched, and strengthened with all available obstructions; and where these are wanting, parapets will be thrown up, or stockades, or barricades of casks and carts filled with earth, stones, or dung, of agricultural implements, &c. Walls liable to escalade should have ditches, trapholes, harrows, &c., inside as well as outside. Iron window-gratings, with the alternate bars turned up, may be good auxiliary obstacles in such situations, as used by Sir C. Smith inside the breach at Tarifa. Free communication will be cleared around the circuit of the defences, and the internal communications barred and defended by cross fire from the buildings.

The artillery, if there are any, will be planted to command the lines of approach still most accessible. Thatched buildings on the outskirts of the village should be unroofed, and banquettes of scaffolding may be laid along near the top of their outer walls. Where a fire may have to be kept up on a column advancing through a street, communications must be broken through the party walls from house to house. Advantage will be taken of any local facilities for inundation to cover a part of the circuit. Additional care will be taken in fortifying any substantial buildings which occupy salient positions on the outline.

One or more edifices should also be selected as keeps for internal defence. These should be approached by ready communications from the outer works, but should completely command those communications. What has already been said on the defence of a building applies here.*

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* A lively example of preparation for the defence of a village on the Caffre frontier occurs in the letter of an engineer officer, which lately appeared in the newspapers:—"As some of them threatened to decamp unless I came into the village, I had to leave my poor little redoubt, and ensconce myself and party in an empty house, which we very soon rendered defensible, to the great horror of the owner, who viewed the tearing off the thatch from the roof, the building up of the doors and windows, driving loopholes through the walls, &c., with great disgust. Having once set the example, it was altogether wonderful to witness the expedition with which the people, who had hitherto stood with their hands

The manner in which fences, &c. may be turned to account in aid of breastworks, is best seen from a few examples in the illustrations.*

Figs. 87, 88, 89, 90, 91, show various examples of common field-fences made defensible. Figs. 92, 93, are highways and their hedges turned to account; figs. 94, 95, 96, different manners of loopholing walls.

The following useful abstract of the various means of barricading is contributed by Captain Nelson, R.E., to the *Aide Memoire*:— †

1. Palisading.
2. Stockade of trees, from esplanades, avenues, canals, gardens, &c., .
3. Stockade of squared baulk, from the timber-yards, ...

   Loopholed; the bottom of the loophole not less than 8 feet above the ground outside.
4. Abattis; with or without parapet of earth and ditch behind.
5. Parapet of baulk, or of logs roughly trimmed—provided they go across the road, and either go into the walls or can be well secured to them.
6. Barrels, hampers, or sacks filled with earth, as a parapet, a ditch in front, avoiding parapets of paving-stones as much as possible.
7. Earthen parapets, with plank revetments, supported by posts.
8. Carts, waggons, &c., jammed and lashed together.
9. Iron railing, removed bodily in convenient lengths, from enclosure walls, areas, &c.
10. Chevaux-de-frise; this only occasionally for particular points, especially for closing passages in the main barricades, as a sort of temporary gate.
11. Sandbag parapets, with chevaux-de-frise in front, and loopholed above; this also is only an occasional resource, &c. &c.

The same officer also furnishes the following thicknesses of ordinary materials, as proved by experiment to be the lowest that can be relied on as musket proof:— ‡

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in their pockets, turned-to to demolish their own, and especially their neighbours' property. A, B, and C, the proprietors of different establishments, were all at hearty small-town feud. If I wanted thatch taken off A's roof, I went to B, who undertook to do it forthwith for the public service; while C volunteered to set fire to B's cattle kraal at any moment required, without any inquiry as to public service whatever. There was a considerable difference of opinion as to whose house should be the "keep" of the village; but every one agreed that his own ought to be made as strong as possible, which, to a certain extent, answered the same purpose."—*Times*, April 23d, 1851.

* Plate VI.

† Vol. i. p. 125.

‡ *Aide Memoire*, vol. i. p. 126.

Walls.	Brick,	1 brick thick.
	Granite, Compact limestone, ... sandstone,	6 inches solid stone.
	Cob, clay and straw,	9 inches thick.

Width of 1-bushel sandbag, at least 10 inches, full of earth.

White pine,	12	inches thick.
Yellow do.,	9	do.
Oak, good,	4	do.
Oak, sheeted with $\frac{1}{8}$ wrought iron,	2	do.
Sheet iron,	$\frac{3}{8}$	do.

In illustration of the subject of the defence of posts, it may be well to append a project called for and submitted in India. Occasion did not arise for carrying out the work.

MEMORANDA TO ACCOMPANY A SKETCH OF THE POSITION PROPOSED TO BE OCCUPIED AS A DEFENSIBLE DEPOT NEAR RAMNUGGUR, ON THE ADVANCE OF THE ARMY BEYOND THE RIVER CHENAB.

(Pl. VI., fig. 97.)

[*N.B.*—The stores to be left behind were contained in about 1000 carts, with about 2½ battalions for their protection.]

The position intended to be occupied is an irregular quadrangle, of about 260 yards by 200 in average length and breadth. Its northern front is the bank from which commences the low plain of the Chenab; the southern face is formed by an oblong enclosure, (A,) in which the engineer department is now posted—formerly, it is believed, a Sikh barrack or cantonment. On the north and north-west, good defensible and flanking posts are afforded in the groups of buildings, (C) and (B). A row of trees, and the remains of mud buildings near a large well, which it is desirable to include in the position, define a portion of the west front. The remainder of the west and the whole of the east must be defined and strengthened artificially.

The long lines will be formed or backed by carts, cases, &c., not containing *combustible* stores, aided, at certain points hereafter specified, by small earthenworks, should labour be available. Treasure, and such other property as is of greatest value, will be deposited in the walled enclosure (A); combustible ammunition-carts will be ranged under the long northern face of the enclosure, outside. The three posts, (A) (B) and (C), will be strengthened by the means now to be detailed, so far as may be practicable. Not less than three companies should permanently occupy (A), and at the least three more may be divided between (B) and (C), the remainder of the troops being encamped closely in the interior of the position, available for the defence of any part of it.

(A) is enclosed by a wall of unburnt brick, about 3′ 3″ in thickness and 13′ high, surmounted by a thin brick parapet about 4′ high. The small towers at the angles are solid, and consequently can only give what flanking defence they are capable of from the top. The gate towers are hollow, but very contracted within. The only existing semblance of a banquette round the building is the ledge, of some 1′ 6″ in width, where the parapet rises from the wall. On the north, east, and greater part of the west faces, a sufficient substitute is found in the roofs of the barracks or storehouses, whilst the ledge just mentioned serves for a communication between them. It will, however, be necessary to provide the means of a musketry defence on the south side. This may be done either by cutting loopholes through the soft wall, at about 6 feet from the ground, and raising a banquette of 1¾ feet in height, or by forming lengths of scaffolding at intervals along the wall, furnished with ladders. The last may be constructed by inserting joists of about 6′ in length, at intervals of 2′, in holes through the base of the parapet. The weight of the parapet, and bearing on the ledge at its base, will make this sufficiently safe, if done carefully, to bear a platform of poles bound down to it.* The loopholes and banquette will require most labour, on account of the thickness of the wall; the scaffolding will expend wood, which is of great value for other purposes, but will probably take less labour. Poles for the platform must be extracted from the roofs of some of the interior buildings, if not to be had from the adjoining town of Ramnuggur. The loopholes in the tops of the towers are useless, and the wall there will scarcely bear their being enlarged. It is proposed to reduce the parapet of the towers to a height fit for firing over. Loops may be made in the cells of the gate-towers.

If the banquette be adopted, a good deal of brick rubbish may be had for the purpose in unfinished buildings within, in the material removed from the tower parapets, and in brick lying outside the enclosure.

(B) is a square pavilion or garden-house of two stories, the lower about 40′ square, the upper about 20′, with terrace roofs. The lower story is arcaded at the sides, and raised on a plinth or terrace of about 64′ square. It is surrounded to some distance by a lemon-orchard, with a few other trees.† These must be thinned, if not cleared away, and may be used as a trifling abattis round the building, or elsewhere, in conjunction with larger trees. The arcade should be blocked up to parapet height, and a parapet raised on the terrace of the lower story. The upper roof has a parapet, but a very low one. Material for these may be taken from the detached brick building (*e*), which forms no part of the position, and had better be destroyed.

(C) is a small tower, about 14′ in internal diameter, with a few out-houses, and is capable of being made, with a little work, a strong post. The edge of the bank on which it stands is already topped by the remains of a mud wall and cactus hedge, which require little more to become an efficient breastwork. There is a dense thicket or jungly garden below, however, containing trees of various sizes: the whole ought to be cut down, and laid as abattis at the foot of the bank. The outhouses will be loopholed, or unroofed and cut down into breastworks, and loopholes must be made in the tower itself. The well on the east must be embraced in the line of abattis. The field in the low ground under the post is surrounded by an earthen fence of some 3′ high, with a ditch outside. It would be desirable to throw down this, as it gives more cover to assailants than defenders, and the area, being low, and of awkward access, is not very well suited to form a part of the depot.

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* See Plate VI., fig. 98.

† Under those trees lie buried Col. Charles Cureton, Col. William Havelock, and Captain Fitzgerald, who fell on the adjoining plain 22d November 1848.

The bank along the north front of the position from B to C should be scarped, (Pl. VI., fig. 99,) and the earth thrown on the top, so as to form a breastwork for the defence, at the same time that the declivity is rendered too high to be taken advantage of by an assailant. The little eminence (*f*) on the east side of (C) is to be treated in the same manner; this, however, must be occupied as a sort of outwork, not included in the general outline. The trees at (*h*) may form an abattis on the flank of (C), and the slight declivity there may be improved by scarping. On the west front, the trees at (*g*) will be cut down into abattis, and the mud-buildings shaped into breastworks with a little aid in digging, so as to include the well.

The double-dotted lines on the sketch show the general form in which the defensible outline will be completed with the carts, &c. of the depot. Should these be sufficiently numerous, they may be extended to embrace the single-dotted line, giving a flanking defence to the exposed face of (A). If still more numerous, the whole face of (A) may be covered by them at 30 feet from the wall.

A general idea of the interior arrangements is given on the sketch. Should the inner space be insufficient for the cattle, the enclosure of the field north of (C) must be retained, and an addition made to the height of the fence by digging its ditch to such a depth as will prevent its being used as a breastwork by the assailants, and by giving it some flanking defence at the angles.

If labour be available, a small earthen parapet (*t*) may be thrown up in front of the gate of (A).

Abstract of work to be done.

[*N.B.*—Those works which are considered most pressing, and are to be first executed, are marked ‡.]

‡ 1.—Reduce the parapets of the towers at the angles and gate of (A) to breast height.

2.—Provide defence for the long south curtain of (A), either by a scaffold under the parapet, or by banquette and loopholes.

3.—Make loopholes in the cells of the gate-towers.

‡ 4.—Clear the trees on the south, west, and north of (B), and build up the arcades breast-high, demolishing the building (*e*).

5.—Make parapets of proper height on the terrace roofs of (B).

‡ 6.—Complete parapet along the north front of (C), loopholing the tower and outhouses.

7.—Clear away the thicket below (C), and form it into abattis at the foot of the bank.

8.—Scarp the bank between (B) and (C) and the hillock at (*f*).

‡ 9.—Form abattis at (*g*) and (*h*), and shape the ruined huts at (*g*) into breastworks, forming also a parapet to enclose the well at (*g*).

10.—Form a small breastwork in front of the gate of (A).

11.—Destroy the fence of the field below (C), if not wanted for cattle.

Camp, Ramnuggur, *November* 1848.

Additional references to the fig. 97, *Pl.* VI.

p, Combustible ammunition.
r, *r*, Troops encamped.
s, *s*, Cattle.
t, *t*, Earthen breastworks.
v, *v*, Barricade of carts.
w, *w*, Wells.

"Mauritius militari Architecturæ totum se primis ab annis impenderat. Cujus usu oppida Belgarum passim munita; et exercitationes scripto vulgatas velut normam artis et legem, Reges plerique Principesque etiam hostes sequuntur."——M. Z. Boxhorn, Hist. Obsidionis Bredæ.

CHAPTER VIII.

PERMANENT FORTIFICATION.—VAUBAN'S FIRST SYSTEM.

> "Beneath, each bold and promontory mound
> With embrasure embossed and armour crowned,
> And arrowy frise and wedged Ravelin,
> Wove like a diadem their tracery round
> The lofty summit of that mountain green."
>
> GERTRUDE OF WYOMING.

THE points in which the construction of permanent fortifications differs from that of field-works, are chiefly dependent on—

1. The vastly greater excavation practicable;
2. The greater length of exterior sides; and,
3. The use of masonry.

We have said before (see page 15) that the distance of flanks from the salient angle which they defend should be considerably within the range of their fire; and in our examples of field-traces this is adhered to, by making the exterior sides 200 yards and under, so as to bring the salients within an easy musket-range of the flanks.

But, in permanent works, one of the advantages which we expect from free expenditure and deliberate execution, is by greatly increasing the relief over what is attainable in a field-work, to increase the command of the work, and to render its capture by surprise or *vive force* improbable, to a degree which cannot be looked for in field fortification.

Now, it has been shown (see page 48) that, with the ordinary form of parapet, in order that every part of the ditch before the curtain of a bastioned front may be seen and defended from the flank, the length of the curtain and the height of the flank must be to one another in the proportion of 12 to 1. This may be somewhat modified, inasmuch as it is not essential to the defence of the ditch that lines of fire from the flanks should strike *the ground* in every part. If the lines from the opposite flanks intersect at 4 feet or less above ground, they may be held completely to defend the ditch. This consideration reduces the necessary length of curtain about 16 yards.

If, then, the exterior side be 200 yards, and the bastions be constructed of the same proportions as in fig. 72,* the length of the curtain will be but 75 yards, and the whole relief only 22 or 23 feet, which would be trifling and insufficient for the objects of a permanent work.

It is therefore absolutely necessary to increase the length of the exterior side, and to increase it, in truth, beyond a good musketry range; making the limit of our line of defence a fair range for grape, and the large pieces called rampart

* Plate V.

muskets. This will be 250 to 300 yards, giving an exterior side of 350 to 400, which allows a relief of between 40 and 50 feet.

Masonry in permanent works is used to revet the escarp and counterscarp. Its use enables the engineer to form these parts of the work perpendicular, or nearly so, so that the work cannot be entered till they are destroyed, unless by the bold and dangerous enterprise of escalade. These walls, in fact, are intended to serve the purpose of high walls in civil life—to keep out trespassers. The scarp wall does not by any means add to the strength of a rampart—*i.e*, to its strength to resist battering guns. On the contrary, the latter is rendered by it more liable to destruction, as the hard masonry broken by shot, and falling in masses, brings down with it the earthen parapet which it supports. It is necessary, therefore, to cover the masonry as much as possible from external fire.

In such works, having deep and wide ditches, with sides of nearly perpendicular masonry, it is manifest that egress from the fortress to the exterior must be maintained by occasional narrow communications, gateways, bridges, staircases, &c.; and that by these the sorties of the garrison must be made, if made at all. If, then, there is no cover beyond the ditch, an effectual sortie is scarcely practicable, as the troops attempting it would have to defile before the enemy; nor, indeed, could even a sentry be safely posted outside the ditch.

The work called the glacis serves both these purposes—viz., of protecting that part of the escarp masonry which is above ground from external observation, and of providing cover for the free circulation of troops, &c., on the outside of the ditch. The glacis is a parapet of the usual height, but having its upper surface extended in one long slope to meet the natural level of the ground. Were it terminated in an abrupt exterior slope like ordinary parapets, it is plain that it would give ready cover to an assailant.

That external communication round the counterscarp, of which the glacis forms the parapet, is termed the *Covered Way*. In addition to its use for the protection of guards and the formation of troops for sorties, it affords a close musketry fire on an advancing assailant.

It is desirable not to make it wider than its purposes absolutely require, in order that it may not form a too convenient site for the enemy to construct his batteries on; but occasional enlarged spaces are provided for the assembly of troops, either for sorties or for the defence of the covered way. These are called *Places of Arms.*

The width of the ditch must be adjusted to the relative levels of the rampart and the covered way, with the glacis before it. The general conditions are, that the covered way shall be so near the enceinte that the fire of the latter on the foot of the glacis shall not be masqued by defenders ranged on the banquette of the former, but that it shall not be too close to the enceinte to be fully seen and swept by the fire of the parapets. To consider these adjustments so nicely as is sometimes done, can only be useful as an exercise of the attention and understanding. A glance at a plan of one of the ordinary systems will show that the width of the ditch and covered way, and consequently the distance of the foot of the glacis from the enceinte, varies greatly on every half-front of a fortress. Hence, to preserve these adjustments accurately, the relief of the works also would require to be varied to a proportionate extent.

Besides the covered way, permanent fortifications are generally provided with other auxiliary works. Where these are within the glacis, and have ditches communicating immediately with the main ditch, they are termed *outworks.* Their names will be best learned in the construction of a particular system. Where such auxiliary works are beyond the glacis, but within musketry range of the enceinte or its immediate outworks, they are termed *advanced works. Detached works* are also intended to retard the advance of an enemy on the main place of strength, but are so far thrown forward as not to be dependent for defence on the parapets of the latter.

It is of the highest importance that all auxiliary works should have ready communication with the body of the place; that their defenders should feel that there is free access for succour to them from the rear, and free means of retreating on their interior defences when they have done their best to maintain the outworks.

The difficulty of keeping up communication across wet ditches has been usually considered a preponderating objection to their use in sites where a choice exists between wet and dry, in spite of the undoubtedly greater obstacle which the wet ditch throws in the way of the assault of a well-provided fortress. In fact, a dry ditch not only affords free communication, but may often be a most safe and useful locality for posting large bodies of the garrison intended as reserves, or for the defence of outworks.* Where the main ditch is dry, it may be possible to obtain, in some degree, the advantage of a wet one by excavating a *cunette* or small ditch in the bottom, where means exist of filling it with water. Such a work the French had prepared at Badajos, at the foot of the counterscarp. It " took from the space calculated on for the formation and movement of the troops in the main ditch, besides causing the loss of many men who were drowned by jumping into the water." †

The masonry revetment generally terminates at the foot of the exterior slope. This is technically called a *demi-revetment*.‡ When the exterior slope is omitted altogether, the wall rising to the superior surface of the parapet, it is called a *full revetment*.§ Sometimes the upper part of the full revetment is a wall breast-high, with a berm behind it, the parapet being thrown back to a distance equal to the breadth of the berm.|| This berm or path is called by the French *chemin des rondes*, because used for going the rounds. Whilst presenting nearly the height of a full revetment against surprise, it affords greater facility for observing the ditches than a banquette behind the parapet; and the distance to which the mass of parapet is retired by this construction renders it less liable to be brought down by the fall of the masonry.

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* During the Venetian defence of Corfu against the Turks, in 1716, Marshal Schulembourg " seems to have kept a large portion of his troops, when on duty, in the main ditch, where they were probably more secure than within the walls."—Account of the Siege, in *R. Engineer Corps Papers*, i. p. 272. In Carnot's and also in Coehorn's Systems of Fortification, the assembly of troops in the ditches is especially regarded.

† Jones's *Sieges*, i. 232. ‡ Fig. 119. § Fig. 117 || Fig. 118.

No definite era for the invention of artillery has yet been ascertained; but its introduction among the European nations dates from the early part of the fourteenth century.* Its employment was not very general till the end of that period, and apparently a hundred years passed before it had so modified the practice of fortification as to induce the use of earthen ramparts.† The towers containing artillery for the defence were generally round.

The earliest modern writer on the subject whose works have been printed appears to be Francesco di Giorgio, an Italian architect of Siena, who lived from about 1423 to 1506.‡ In the projects which he delivers in his work, (first published at Turin in 1841,) flanking defence is derived from round towers at the salients, either immediately attached to the enceinte, or connected with it by double walls or galleries.§ In place of, or in addition to, these, he sometimes employs vaulted shot-proof caponières, in the form of which the bastion is distinctly indicated, and which are, in fact, an exact miniature of the works projected in the latter part of the eighteenth century by Montalembert, and carried out of late years in many German fortresses. The glacis and covered way, a cunette within the main ditch, escarp galleries, fausse-brayes covering the curtains, and a ravelin, (by that name,) || are all to be found in his designs. The rampart is described as a double wall with counterforts, the intervals being filled with earth.

As artillery improved, a corresponding improvement in the power of defence became one of the desiderata of the age; and several of the great geniuses who then adorned southern Europe gave much attention to the subject. Military engineering was one of the countless arts in which Lionardo da Vinci* was a master, though he does not appear to have left any work on the subject; Machiavelli treats fortification as a branch of his Art of War (1521) with acuteness and judgment, though not in much detail; and Albert Durer published a book on the subject, (1527,)† the speculations of which appear to have influenced the projects of Montalembert, and the construction of works in Austria within the last few years.

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* "Casiri mentions its employment by the King of Granada at the attack on Baya, in 1312. In Italy, Dr Gaye found 'pilas seu pallectas ferreas et canones de metallo' enumerated among the war provisions for Florence, Feb. 11, 1326." —*Quarterly Review*, CLXXII.

Barbour mentions "crakys of war" as first used in Scotland by Edward III. on his expedition in 1327.

† Earthen ramparts were, however, frequently used by the ancients. Vegetius (iv. 3) recommends for a rampart a double line of wall, with an interval of twenty feet to be filled with earth and well rammed.

‡ See Note E, Francesco di Giorgio. § See Pl. V., fig. 84. || *Rivellino.*

Bastions of the present form are usually said to have been first constructed by Michael San Michele,‡ an eminent Italian architect and engineer, at Verona, about 1527, a date which is inscribed on one of the bastions of that city; but, as has been mentioned, the bastion trace is pretty distinctly indicated in the work of Francesco, and the improvement is not one of a kind to which an exact date is likely ever to be assigned.§ The manner of applying bastioned fronts was brought to a considerable pitch of advancement by the Italians and Spaniards during the next hundred years, as may still be seen in the Low Countries, (the citadel of Antwerp, for example,) and in part of the gigantic works at Malta—such as the land-fronts of Valetta, (1568,) with their scarps reaching to a height of 170 feet, and the large and powerful bastions of the suburb Floriana (1635). The new system found its way as far north as Leith in 1549, when that port was fortified with eight bastioned fronts by the gallant owner of a name illustrious in the later history of military architecture, André de Montalembert, Chevalier d'Essé;||

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* 1452-1519.

† See Note F, Albert Durer's *Fortification.*

‡ See Note G, San Michele.

§ See Note I, *Early Indications of Bastions.*

|| Born in Poitou, in 1483, he was from his youth distinguished in the Italian wars. In 1543, he defended successfully, for three months and a half, against the Emperor Charles V., the town of Landrecies, the works of which were at the time in such a state that, says Brantôme, "on la disoit n'estre faicte que de boue et de crachats." In one of his sorties the garrison captured a piece of cannon, and tumbled it into the ditch. In 1549 he was sent to Scotland in command of the French troops which went to aid Mary of Guise. On his return he was received with high honour; and soon after was commissioned to defend

and a quarter century later, Berwick was encompassed with the ramparts which still exist.*

Italians for a long time were the engineers of almost all the armies in Europe. Gabriel Martinengo of Brescia was chief engineer to the order of St John in their heroic defence of Rhodes in 1522. The engineer who fortified Antwerp for the Duke of Alva, in 1568, was Paciotto, an Italian;† and an Italian likewise was Frederick Gianibelli of Mantua, who was sent by Queen Elizabeth to aid the burghers of the same city in their resistance to Alva's successor, the Duke of Parma, in 1585. He had previously been employed in England, where he superintended the formation of a bastioned enceinte to Carisbrooke Castle.‡ Even on the remote banks of Tweed and Teviot, in 1544, when Lord Hertford invaded Scotland, we find our "auld Inymis of Yngland," with an "*Italian fortifyer*," helping them to batter down the abbey of Kelso, and to turn its ruins into a redoubt,§—a devastation which now our neighbours doubtless ascribe to John Knox.

Machiavelli says that the Italians had little skill in fortification before the invasion of the country by Charles VIII. of France, in 1494, and ascribes to imitation of the French the improvements which had taken place in his time. This certainly did not continue to be the relative rank of the two nations, as regarded the art of fortification. The engineering genius of the French, who in later times have been our great

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Therouanne against the Emperor. On the breach of that place, he was shot dead by a Spanish soldier, (1553.)

* See in fig. 114, an outline of D'Essé's fortifications at Leith, from a plan of Leith and Edinburgh, engraved on wood in 1577 from a survey made by Queen Elizabeth's engineers during the siege of Edinburgh Castle in 1573. The works at Berwick consisting of bastions with square orillons and cavaliers, are shown in fig. 115.

† Schiller's *Revolt of the Netherlands*. Larger bastions were thrown out in the succeeding century; but Paciotto's works exist as cavaliers within the enceinte. One of the bastions still bears his name.

‡ In the next century also Pompeio Romano conducted the works against Ostend under Spinola (1604), and many years afterwards was called to France by Richelieu to act as chief engineer against Rochelle (1627).

§ Preface to the Chronicle of Kelso Abbey, by Cosmo Innes, Esq. (Bann. Club.)

authorities on fortification, made little advance during the sixteenth century; whilst during that age Italy was not only distinguished in the practice of the art, but produced a copious literature connected with the subject.* Among the most notable works of this period may be mentioned that of Nicolo Tartaglia,† (1546,) the first in which a bastioned system is regularly treated; the military architecture of Francesco de' Marchi,‡ (1546;) and a work published at Venice in 1564, containing intermixed chapters on fortification by Girolamo Maggi and Captain Jacopo Castriotto.§

The weakness of French fortresses was felt by Sully, who had himself been distinguished by his engineering skill in the attack of many of them, and who, in addition to his duties as first minister of state and finance, and lieutenant of the king's armies, held the offices of grand-master of the artillery and superintendant of fortifications. He endeavoured to amend matters by associating, in 1604, a body of instructed engineer officers, (a corps such as did not exist in England for a century and a half afterwards,‖) and by encouraging essays on the subject. The first French writer was Errard of Bar-le-Duc, whose work was published in 1594, followed in the next reign by Deville, (1628,) and Fabre, (1629.)¶ In all, the trace of the bastions is bad, the flanks being drawn perpendicular to the curtain, or even to the faces, (as in Errard's construction,) and thrown back from large towers at the shoulders called *Orillons*, which occupy two-thirds of the space available for the flank—thus *throttling*, as it were, the bastions, and giving them much the appearance of the ace of spades. The most judicious of the early French writers is the Count de Pagan,** whose treatise was published in 1645. The trace which he laid down has a great general resemblance to that of Vauban; but his bastions, of sufficiently spacious outline, and traced with right angles of defence, have their interior cut up by three tiers of guns rising one behind another on the flanks.

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* At least thirty works before 1600. See a list communicated by Major Portlock, Royal Engineers, to the Corps Papers, vol. i. p. 62.

† See NOTE J, Tartaglia.

‡ See NOTE K, Marchi.

§ See NOTE L, Maggi and Castriotto.

‖ Established in 1757. See Glossary, Art. *Engineer*.

¶ See NOTE M, De Ville.

** See NOTE N, The Count de Pagan.

The best projects of the writers named do not appear to have surpassed what had been already executed or suggested by the Italians, and their principal claim to notice lies in their reflected honour as the professional ancestry of VAUBAN.

The system of permanent fortification usually taught is called the *First System of Vauban.* It was never laid down by that illustrious soldier methodically as a system, but has been deduced by the engineers who succeeded him from an examination and comparison of the numerous fortresses which he constructed or renovated, such as Lille, Strasburg, and Givet.*

The general outline of every fortress is considered as a polygon. In fact, this polygon will generally be irregular, since local circumstances give rise to inequalities in the different sides and angles; but in the study we consider the polygon as regular. The side of the polygon is that line which has been already mentioned under the technical name of the *exterior side.* Its length has been shown to be determined by certain fixed conditions. Whatever number of sides, therefore, the polygon inclosing a place consists of, the length of each side is the same. Hence, the larger the fortress, the greater must be the number of sides.

On each exterior side is constructed a front of fortification. We now describe how this is done according to Vauban's first system.

In field fortification, it was stated that the magistral or guiding line of the trace is the crest of the parapet. In the common systems of permanent fortification, it is the line representing the position of the *cordon* or coping stone of the escarp revetment.

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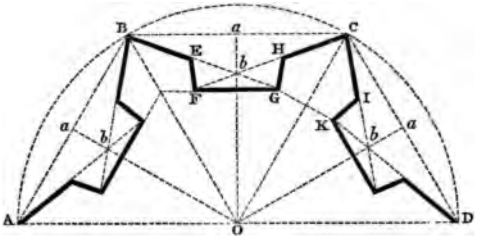
* "Books have appeared, professing to give *M. de Vauban's Genuine System of Fortification;* but he always said, and he showed in practice, that he had no system. Every different place furnished him with a new method, according to the different circumstances of size, position, and ground. The most difficult of all arts are those of which the objects are variable; which do not permit the application of fixed rules by limited intellects, but which demand at every moment the natural and prompt resources of a happy genius."—FONTENELLE, *Eloge de Vauban.*—See NOTE O, Vauban.

DETAILS OF CONSTRUCTION.

Let A B C D be a part of the polygon,—in this case, a hexagon—having each of the sides 360 yards* in length. Bisect the sides in *a a a* by the perpendiculars O *a*, O *a*, O *a*. Make the *perpendicular a b* equal to $\frac{1}{6}$ of the exterior side B C, and through *b* draw lines from the angles of the polygon. Along these lines set off C H, B E, &c., each equal to $\frac{2}{7}$ of the exterior side. From E and H, with the radius E H, describe arcs cutting B *b*, C *b*, produced in G and F. Join E F, G H, F G. This being completed, on every side of the polygon we recognise a bastion trace of which (in the front B C) B E, C H, are the faces of the bastions; E F, G H, the flanks; F G, the curtain; B G, C F, the lines of defence.

Cut 1.



The angle of the bastion at C or B is called the *flanked angle;* B E F or C H G, the *shoulder angle;* E F G or H G F, the *curtain angle;* B C H or C B E, the *diminished angle;* E F C or H G B, the *angle of defence.*

G K is the *gorge* of the bastion; and where the curtains are produced to meet in the middle of the bastion, as in bastion B, each prolongation is called a *demigorge* of the bastion.

Moreover, O *a* is called the *right radius*, O B the *oblique radius*, and the curtain line extended both ways to meet the oblique radii is called the *interior side.* But some of these technicalities are of little or no use.

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* The French dimensions is 180 toises, which would be 383 yards, the toise being greater than 2 English yards by .131. But as in several English text-books the dimensions have been rendered at 2 yards to the toise, which gives round numbers, and makes no practical difference to a beginner, we follow that example here. In the construction of the modern system which follows, the more accurate rendering of the French dimensions is adopted.

We have said that the perpendicular in this case is $\frac{1}{6}$ of the exterior side. It is plain that the flanked angle of the bastion diminishes as the perpendicular increases, and that it also diminishes as the number of sides in the polygon diminishes. Hence, in a low polygon with long perpendiculars, the salients of the bastions would be excessively acute. The rule therefore is,—to a square, make the perpendicular $\frac{1}{8}$ the exterior side, (which will give salients of about 60° opening;) on a pentagon, make it $\frac{1}{7}$, (which will give salients of 76°;) in a hexagon or greater polygon, make it $\frac{1}{6}$, (which will give in a hexagon 83° for the salients, in a heptagon 92°, in an octagon 98°.)

It will be observed that the angles of defence are in a slight degree acute. In this Vauban has gone back in a measure towards the old construction of the flanks, from that laid down by Pagan. His object may be conceived to be, that the fire of the outer flank guns may bear more directly on the salient of the bastion and the probable situation of a breach. Later authorities have adopted the right-angled trace for the lines of defence.

The main ditch is 30 to 36 yards wide before the bastion. The counterscarp is represented by arcs of a circle described with a radius of that length from the salients of the bastions as centres; its outline being completed by tangents to those arcs drawn from the shoulder-angles of the collateral bastions.

The main line of rampart and parapet, as distinguished from outworks, is termed the *Enceinte.*

Cut 2 is an outline plan of the enceinte and outworks of one front of fortification.

The great triangular work A is called the *Ravelin*, or sometimes *Demilune.**

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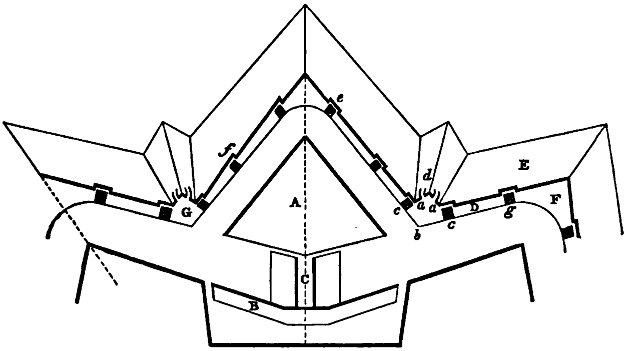
* This name of *Half-moon* appears to have been originally applied to a sort of *bonnet* or detached bastion thrown out to cover the towers of old fortresses. This was generally of a cocked-hat shape with the gorge in the form of a crescent. There are, however, instances of semicircular works in the position of the ravelin, an example of which (according to the *Penny Cyclopædia*) exists at Carisbrooke Castle.

D F is the Covered-way, and E the glacis. B is called the *Tenaille*, and C the *Caponière*.

These works are traced as follows:—

Ravelin.—From the re-entering angle of the counterscarp before the curtain, set off 100 yards along the perpendicular produced outwards; the point so fixed is the position of the salient of the Ravelin.* Its faces are directed upon points on the faces of the bastions 10 yards distant from the shoulder-angle.

Cut 2.



The ditch of the ravelin has a uniform width varying in different instances from 20 to 24 yards, the counterscarp being rounded at the salient like the main ditch.

Covered-Way and Glacis.—The covered-way is 10 yards wide, extending all round the counterscarp, which forms its inner edge. Its outer edges meeting in an angle at each salient whilst the counterscarp is rounded, enlarged spaces are so enclosed, which are called the *Salient Places of Arms.* Places of arms are also provided at the re-entering angles of the covered-way by the following construction:—From the angle of the counterscarp *b* measure *b c*, *b c*, equal to 36 yards each way. Raise perpendiculars *c a*, *c a*, and from the points *a a*, where they intersect the outer edge of the covered-way, draw *a d*, *a d*, forming angles of 100° with that line. The space so formed, is called the *Re-entering Place of Arms.*

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* This makes the ravelin somewhat larger than the outline deduced by Noizet de St Paul from actual works of Vauban. The rule he gives is, to make the face of the ravelin $\frac{2}{3}$ of the exterior side, the same as that of the bastion. Bousmard's version of the construction still further contracts the ravelin. He fixes its salient by describing an arc from the curtain angle as centre, and the distance from that point to the opposite shoulder as radius, to intersect the produced perpendicular. But this method, according to his editor, is only applicable where the face of the ravelin is directed immediately on the shoulder angle, so as to leave the whole fire of the bastion unmasqued, the flank and shoulder itself being covered by an *orillon*.

The outer edge of the covered way with its places of arms, which we have thus defined, is the crest line of the Glacis (E), the latter serving as a parapet to the covered way. The slope of the glacis is 40 yards in width.

To protect the covered-way from enfilade fire, Vauban introduced traverses at right angles to the direction of its branches. There are usually two of these on each of the branches before the bastion, and three on those before the ravelin. The lines *a c*, *a c*, mark the crests of the traverses adjoining the re-entering places of arms. The faces of the bastion and ravelin produced to intersect the counterscarp, will determine the point at which the base of the exterior slope of the traverses adjoining the salients is to be drawn. In the long branches before the ravelin, a third traverse is inserted midway. As the traverses extend the full width of the covered-way, it is necessary to provide passages round their ends by cutting into the glacis. These passages are called *Crotchets*, and are either *double* as at *e*, or *single* as at *f.* They are 9 feet in clear width each way.

The *Tenaille* (B) has its faces on the lines of defence. The thickness of the work is 16 yards, and spaces of 8 yards in width are left between its extremities and the flanks of the bastions. These are called in French *Trouées* of the Tenaille.

The *Caponière* (C) consists of two broad glacis-like parapets, with a passage between them, running athwart the main ditch. The breadth of each slope is 20 yards, and the width of the passage from crest to crest is 11 yards. A clear way of 9 feet wide is left between the slopes of the caponière and the gorge of the ravelin.

The ravelin serves to bring a powerful fire on the ground before the salient of the bastion; it covers in a great degree the flanks, curtain, and tenaille from distant fire; and it forms a strong additional work to be captured before a breach in the bastion can be stormed, thus compelling the enemy to employ increased force and labour on his attack. The ravelin, also, by its salience, creates two re-entering angles suited for the establishment of places of arms for the defence of the covered-way. Short flanks are sometimes given to the ravelin, in order to bring a more direct fire to bear on that part of the face of the bastion which is most liable to be breached; but this construction, applied in Vauban's outline, exposes the shoulder angle to be directly battered from the glacis.

In many old European fortresses, (and in very many places in India,) we find a second line of parapet called *fausse-braye* encircling and attached to the enceinte, generally on a level with the plane of site, and intended to afford a fire on the counterscarp. This, from its breaking the height of the escarp into two stages, facilitates capture by escalade; and its lines, being below the crest of the glacis, are peculiarly liable to enfilade from the enemy's batteries established there, whilst its fire upon the country is masqued by the glacis in the front. It also encroaches greatly on the space of the bastions. Hence, it has been long disused in Europe; but the tenaille, introduced by Vauban,* at Lille in 1670, may be taken as representing a partial *fausse-braye*. It is detached from the enceinte, so that the escarp of the latter retains its full height, and the defenders of the tenaille are not liable to be impeded and overwhelmed by splinters and rubbish detached by the enemy's shot from the upper part of the wall of the curtain. At the same time it hides more than two-thirds of the escarp of flank and curtains (with their posterns) from the fire of the enemy's breaching batteries established on the glacis or ravelin, and it gives a close fire of musketry on the interior of the ravelin. It also serves in a dry ditch to protect the assembly of troops for a dash at the enemy descending into the ditch, or for the support of the outworks; and in wet ditches it affords a covered harbour for boats. As there is scarcely any *remblai* in the tenaille, an amount equal to its mass is saved in excavation. At Huningen, Sarre-Louis, and other places, Vauban constructed this work like a small front of fortification, with its flanks parallel to those of the adjoining bastions.

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* See NOTE P, *the Tenaille.*

The caponière, as here constructed, affords cover to the communication with the ravelin from distant shot enfilading the main ditch; but as it is useless when the enemy are established on the glacis before the bastions, it is often recommended that it should be constructed of bomb-proof masonry. The bomb-proof caponière provided with loopholes, or enlarged to contain artillery, may form an important work for the active defence of the ditch; and large caponières of this kind are in fact the great features of some modern German fortresses.

The escarp masonry Vauban usually made about 5′ thick at the level of the rampart terreplein; the wall above this in a full revetment is perpendicular, and only 3′ thick. Counterscarp revetments he made 3′ 3″ thick at top.

The revetments in this system have a slope of $\frac{1}{5}$ the height to the cordon. The escarps are further strengthened in rear by perpendicular *counterforts* or tie-walls. These are placed from 15 to 18 feet apart. The rule for their dimensions in plan is as follows:—

For a revetment 10 feet high, make the counterfort 4′ long and 3′ thick at the root. For every additional 5′ of height, add 1 foot to the length and 6″ to the thickness of the counterfort. Make the thickness of the counterfort at the *tail*, or part furthest from the wall, always $\frac{2}{3}$ of the thickness at the root.

The depth and breadth of revetment foundations will depend entirely on local circumstances. They may be drawn the same for all the revetments, 3′ deep, and 1′ wider to the front than the base of the wall.

Either full or demi revetment may be applied to this system, but Vauban usually employed the full revetment. In his treatise on the Defence of Fortresses, he gives the preference to that modification of the full revetment which leaves a *chemin-des-rondes* between the wall and the parapet.

A bastion in which the rampart occupies the whole interior space, is called a *full bastion.* Where the rampart follows the angles of the trace, leaving the middle as the natural level, it is an *empty* or *hollow* bastion.

All the parapets, including the glacis, traverses of the covered-way, and caponière, are provided with banquettes for musketry, excepting the actual position of guns on the ramparts.

The following may be taken as the widths of the slopes of the different works:—

The superior and interior slopes of the parapet have the same width in all the works, except the tenaille, viz., the former 18′, the latter 1½′, which may be drawn as 1′ where partially covered by the banquette.

The banquette may be drawn with the same dimensions in all the works, viz., tread 5′, and slope 6′.

Body of the Place.

Interior slope of rampart,......	17′ feet
Terreplein of do., including banquette, and interior slope of parapet, ...	36′
Exterior slope of parapet, omitted with full revetments, ...	
Slope of revetment ⅕ of the height—with full revetments, ...	7′
With demi do., ...	5′ 6″ *

Ravelin.

Interior slope of rampart,......	9′
Terreplein, including banquette and interior slope,	30′
Exterior slope omitted with full revetments, ...	
Gorge revetment,................	3′ 6″
Escarp do.,........................	5′ 6″

Covered-Way.

Slope of counterscarp revetment,..................	3′ 6″
Exterior slope of traverses,	5′

Tenaille.

Terreplein,......................	33′ feet.
Superior slope,..................	15′
Slope of gorge revetment,...	3′ 0″
Do. escarp,..................	3′ 0″

Ramps for the ascent of troops and guns to the terrepleins of the ramparts will be constructed on the flanks of the bastion, when empty, and at its gorge when full. They will also be constructed for the rampart of the ravelin near the salient.

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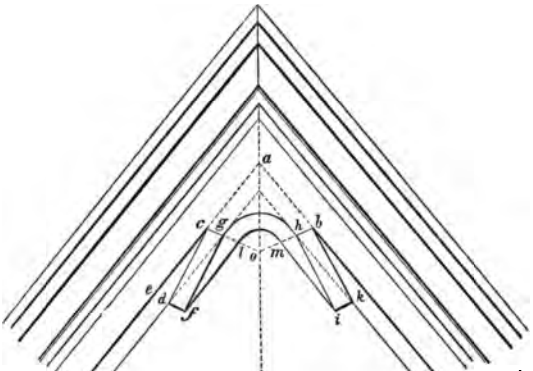
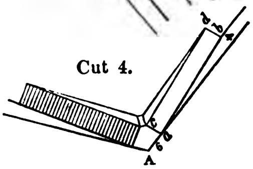
* These masonry slopes are given to the nearest half-foot.

The length of a ramp depends, of course, on the height which is to be ascended, and the space which it may take up without inconvenience. It varies in its ratio from 6 times to 10 times the height. For the enceinte the ramps may be made 50 yards long and 5 wide; in the ravelin, 20 to 25 long and 4 wide. Cut 3 shows the construction of the ramps ascending to the rampart of the ravelin.

Cut 3.



Cut 4.

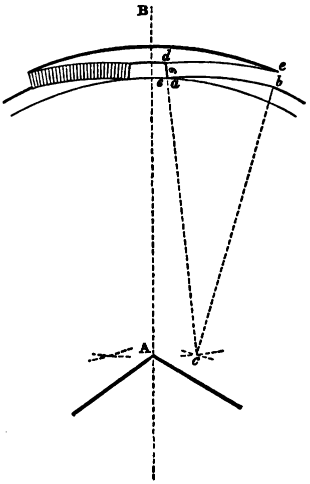


It is usual to construct barbettes, for 1 to 3 guns, at the salient angles of both bastion and ravelin. For each heavy gun in barbette should be allowed a space of 6 yards in width along the parapet, by 8 yards in length.

Communications.—To communicate with the ditch from the interior of the fortress, a tunnel, or arched passage, called a postern, is carried under the middle of the curtain rampart. This extends, in a dry ditch, to 6 feet from the bottom, and for the remainder of the descent, a movable gangway of timber is provided. A similar tunnel, passing under the middle of the tenaille, communicates with the caponière.

Staircases ascend from the ditch to the tenaille, the ravelin, and the re-entering places of arms. The length of the staircase in each case varies with the height of the wall which it ascends. Supposing each step to be 8″ high, a wall of 20 feet will require 30 such steps. The breadth of the staircases is 6 feet, and the first step forms a landing also 6 feet in width. If the remaining steps be each 1 foot wide on the tread, omitting the upper step—which is, of course, level with the top of the wall—the whole length of the staircase, from the landing upwards, will be 28 feet. Cut 4 illustrates the construction of a double staircase at the re-entering place of arms. Staircases at the salient place of arms, also, are often constructed as in the next cut (5); but they are not to be recommended, as the retreat of the defenders of the covered-way should be from traverse to traverse, and so by the re-entering place of arms to the ditch.

Cut 5.



Ramps are to be preferred to staircases whenever there is room for them, as the latter are liable to be rendered useless by shells.

Passages, called *sallyports*, are cut in the glacis for the egress of troops from the re-entering places of arms. These are curved, that they may not be enfiladed from the exterior.

The banquette of the covered-way and traverses is lined throughout with strong palisades. Barrier-gates close the sallyports and passages round the traverses.

Besides these communications with the outworks, provision must be made in a fortress for the traffic of the inhabitants, and admission of the main roads of the country. For these avenues the fronts least liable to attack are generally selected. The road enters the covered-way by a winding cut in the glacis, crosses the ditch of the ravelin by a bridge, passes by a gateway under the rampart of the ravelin, by a second bridge to the tenaille, through its parapet, and by a third bridge to the escarp of the enceinte, where it enters the fortress by a second great gateway in the middle of the curtain rampart.

Sufficient data have now been given for constructing a detailed plan of the system. This will exhibit all horizontal dimensions. To construct a profile on any given line, the horizontal measurements along the line can be taken from the plan, and the following table affords all other necessary information for laying down the vertical dimensions.

Total relief of enceinte, 43 feet; viz., 25′ above plane of site, and 18′ below it.*

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* It is to be remarked that there is a great variation in the profiles ascribed to this system. The dimensions here given are those taught at the Royal Military Academy. Commands are sometimes assigned to the system which appear to partake too much of the *rasant* character which belongs rather to the later French school. The slight elevation of these works above the surface agrees little with the idea which in this country we form of a great fortress. Such a construction is so rare in Great Britain, that probably many students have never seen an earthen rampart and parapet. The following is a vivid sketch of the impression made on Sir Walter Scott by a first visit to the great fortresses of the Netherlands:—" I am well enough accustomed, as you know, to read the terms of modern fortification in the *Gazette*, and to hear them in the narrative of your military experiences; and I must own that bastions and ravelins, half-moons, curtains, and palisades, have hitherto sounded in my ears every whit as grand and poetical as donjons, and barbicans, and portcullises, and other terms of ancient warfare. But I question much if I shall hereafter be able to think of them with the same degree of respect. Through a country as level as the surface of a lake, you jolt onwards in your cabriolet, passing along a paved causeway, which, as if an inundation were apprehended, is raised upon a mound considerably higher than the champaign country which it traverses. At length you spy the top of a poor-looking spire or two, not rising proudly pre-eminent from a group of buildings, but exhibiting their slender and mean pinnacles above the surrounding glacis, as if they belonged to a subterraneous city, or indicated the former situation of one which had been levelled with the ground. The truth is, that the buildings of the town, being sunk to a considerable depth below the sloping ramparts by which it is surrounded and protected, are completely hidden; and the defences themselves, to an inexperienced eye, present nothing but huge sloping banks of earth, cut into fanciful shapes and angles, and carefully faced with green turf. Yet the arrangement of these simple barriers, with reference to the command of each other, as well as of the neighbouring country, has been held, and I doubt not justly, the very perfection of military science; and, on a nearer approach, even the picturesque traveller finds some gratification. This is chiefly experienced at the entrance to the town. Here, turning at a short angle into a deep and narrow avenue, running through these mounds, which at a distance seemed so pacific and unimportant, he finds himself still excluded by drawbridges and ditches, while guns placed

Height above Plane of Site.

Crest of parapet of enceinte	25′
Cordon of do., with full revetment,	17′ 6″
Cordon of do., with demi-revetment,	10′
Crest of parapet of tenaille,	5′
Do. of do. ravelin,	17′
Do. of glacis,	8′
Do. of traverses in covered-way,	7′ 6″

Height above bottom of Ditch.

Crest of caponière,	9′

The various terrepleins may have the following amount of slope to the rear, to facilitate drainage:—

Terreplein of enceinte,	0 6″
Do. tenaille,	0 6″
Do. ravelin,	0 6″
Interior of do., (rise towards the salient,)	2′ 6″
Covered-way,	0 6″

on the adjoining batteries seem ready to sweep the ground which he traverses. Still moving forward, he rolls over drawbridges whose planks clatter under the feet of his horses, and through vaulted arches, which resound to the eternal smack of his driver's whip."—*Paul's Letters*, II.

"Ossibvs et memoriæ Petri Navarri Cantabri solerti in expvgnandis vrbibvs arte clarissimi Consalvvs Ferdinandvs Lvdovici filivs Magni Consalvi nepos Svessæ princeps Gallorvm partes seqvvtvm pio sepvlchri mvnere honestavit cvm hoc in se habeat præclara virtvs vt vel in hoste sit admirabilis."*

CHAPTER IX.

MODE OF ATTACKING A FORTRESS.

—————— "Others to a city strong
Lay siege encamped; by battery, scale, and mine
Assaulting; others from the wall defend
With dart and javelin, stones and sulphurous fire;
On each hand slaughter and gigantic deeds."
PARADISE LOST, xi.

1. **Before** proceeding to describe modern improvements on the system of Vauban, it is desirable to explain briefly the

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* Inscription on the tomb of Peter Navarre at Naples, from the *Monumenta Illustrium Virorum et Elogia—Trajecti ad Rhenum*, 1671.

mode of attacking a fortress, in order that it may be seen where improvement in the defence is wanted.

The first step of the besieger is to *invest* the fortress; that is, to post troops on every side of it, so as to preclude the garrison from communication with the exterior, and to debar them from all aid in men, food, or ammunition. The investing army will strengthen their position by field-works, &c., as in any other case, according to the judgment of the general; and if the hostile power has an army in the field so strong as to be formidable to the investment, it will be necessary to have a sufficient force to watch and check them, called *an army of observation.*

Fortresses are not kept, even during war, constantly garrisoned to the extent which a siege demands, as it is of importance to retain the services of the troops in the field, until there shall be a probability of attack. Strong places, too, which have been made depôts of food and ammunition for the supply of an army, may at many periods of a war be almost drained of their stores. Hence, it may be of the greatest consequence to effect the investment by surprise, if possible. Thus Tournay, one of the strongest fortresses in Europe, with its works in the best state, and all its magazines of ammunition filled, was, by the masterly manœuvres of Marlborough and Eugene, invested and laid siege to (1709) when the garrison was not half equal to its defence, when half the officers were absent, and even this scanty proportion of troops was ill supplied with ammunition.

A rapid movement of corps to commence investment should, however, be made in such strength as to insure superiority in any action with the garrison. "When Lord Wellington reconnoitred Badajos in 1811, his escort, consisting of a strong body of light troops and some cavalry, forded the Guadiana, and arrived unexpectedly in front of the town, whilst the sappers, with the carts and waggons of the garrison, attended by an escort of two or three battalions, were two leagues from the place felling wood, and they were, consequently, cut off from all possibility of returning into Badajos, had the circumstance been known. As it was, they arrived so near the defences before any arrangement could be made for attacking them, that the garrison sent out additional troops to cover the entry of the convoy, which, thus supported, forced through the British, occasioning them a considerable loss." *

The advantages on the side of the garrison in the contest which is about to ensue, are in greater or less degree those which we have laid down as the characteristics of fortification, (p. 2.) Those on the side of the besiegers are superior numbers, and his position on the circumference of a circle, of which the besieged occupy the middle, enabling him to choose and multiply the points of attack, to concentrate his fire, and probably to enfilade the lines of the fortress.

Were he, trusting to his superior numbers, to advance at once and openly to storm the works, he would give the besieged the full benefit of their advantages, exposing his men without protection to the fire of troops covered by parapets, facing all the difficulties of lofty walls to be descended and scaled under a carefully arranged system of overwhelming flank fire, or of planting his guns, to breach these walls, on sites which the forethought of the engineer has taken care completely to command by artillery on the vantage-ground of the rampart.

Where, as has often happened, there has been little science expended on the works of defence, proportionably little will be required in the attack. Where outworks are wanting, flanks distant and imperfect, counterscarps low or absent, and escarps visible nearly to their foot from a distance, it may be sufficient to throw up a battery out of musket-shot from the ramparts, breach the place, and storm it. But the besieger must act differently where his attack is directed, as we must suppose, against defences scientifically arranged.

Carefully planting his batteries so as to enfilade the lines which bear upon his advance, or by a concentrated fire to silence such as he cannot enfilade, he uses the working parties which his superiority of force affords to throw up parapets for the protection of his guns, of the troops which guard them, and of their communications with the rear. As soon as the fire of his batteries has produced its effect on the defences of the place, he throws forward his working parties, casts up new

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* Jones's *Sieges*, i. 414.

cover, and erects, if necessary, new batteries to reach those works which were beyond range of the first. Still, all his guns continue to play upon the lines of the fortress, preventing the revival of their fire. As he comes within range of the musketry of the covered-way, he resorts to the aid of sapping to carry on his advances. Directing his course on the capitals of the salient angles, where he is exposed to no fire in front, he carries forward his trench or covered road by zigzags, shielded by his parapet on the right and left alternately; never exposing himself to the enfilade of the most salient outwork, and not failing to throw out fresh cover for an ample guard, whenever his approaches have advanced so far as to be beyond the reach of prompt aid from that already established. As he draws near the foot of the glacis, he plies the covered way with shells from mortars and howitzers—then saps up its salients—throws up, if necessary, lofty parapets, from which his musketry can pick off the defenders who still attempt to man the shattered salients and traverses; till, having fairly dug his way to the crest of the glacis, he strikes off trenches right and left, following its outline, until he has established a secure communication immediately overlooking the covered-way all round the front which he attacks. Here he has the escarps in view, and here he establishes his batteries to breach them, and to demolish the flanks which may still threaten to dispute his advance against the bastions. Whilst these operations are going on, a descent into the ditch is accomplished, either by sinking mines to blow in the counterscarp, or by excavating a sloping subterraneous gallery. As soon as the breach, if on an outwork, is practicable, the sap is carried across the ditch and up the fallen rubbish, and a lodgment formed on the rampart; if on the enceinte, giving access to the whole fortress, (should the garrison not capitulate), the breach is stormed, and with the success of the assault the place falls.

Before entering into details of the method of modern attack, it may be interesting to furnish a brief sketch of its development.

The classical manner of siege by means of great wooden towers, used as movable cavaliers, continued to be practised in the middle ages, when these cumbrous machines are often spoken of under the name of *belfreys* or *cat-castles.*[*] The advance of these was backed by a mechanical artillery, which, however slightingly we may be disposed to think of it, was directed with sufficient force and accuracy to effect practicable breaches.[†] The latter object was also frequently attained, as in ancient times, by running mines under the walls, which were propped up by dry timber, ready to be fired at the right moment. The use of cannon must soon have abolished the system of attack by movable wooden towers,[‡] but the old mode of mining continued to be employed for a century and a half after the introduction of gunpowder. Mines charged with powder were first tried by a Genoese engineer, at the siege of Sarzanella, in 1487, on which occasion they failed. Peter Navarre,[§] one of the earliest modern engineers of eminence, had witnessed the attempt, and repeated it on several occasions in the service of Spain; till, in 1503, his efforts were crowned with complete success in the capture of the Castel del Ovo at Naples—a fortress of which Froissart had remarked, a century before, that it was "impossible to take it but by necromancy and the help of the devil."[||]

The attack of places, in the sixteenth and early part of the seventeenth centuries, appears to have consisted generally of two approaches indifferently defiladed, sometimes by an imperfect zigzag trace, but oftener by frequent redoubts; by short places of arms parallel to the front, the parapets of which were made high enough to cover the direct trench in their rear; or by traverses at right angles to the trench. Sometimes the approaches consisted of two long defiladed lines starting from distant points of the investment, and crossing one another near the glacis. In both cases the approaches were united near the counterscarp by a parallel or crowning lodgment. The principal battery was established with the earlier part of the approaches, and between them,* sometimes having another on each flank. These batteries directed their fire on the town and works indiscriminately, and were usually contained in redoubts or forts carefully strengthened.† In the earlier part of the period mentioned, the batteries were raised to a great height, in order to command the attacked ramparts; hence they are frequently termed *mounts.*‡ In the long-continued wars of the Low Countries, from 1568 to 1648, when almost every fortress on the Dutch frontier seems to have been several times taken and retaken, much experience was acquired in the attack, and the details of practice much improved, especially by the great soldiers of the house of Nassau—Maurice, and his brother Frederic Henry—as well as by their illustrious opponent, Ambrose Spinola. From all parts of Europe, adventurers flocked to this school of war. Among other comrades of Prince Maurice was Sir Francis Vere,§ whose skill and energy in the defence of Ostend and other places, may claim for him a place in the brief list of eminent English engineers, as well as in that of great captains.

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[*] *Beffrois* and *chas-chasteils.* The latter name was given to this engine, according to Geoffrey de Vinsauf, (iii. 8,) because, like a *cat,* it crept up and adhered to the walls. *Katze* is still the technical German term for a cavalier.

[†] Acre, when besieged by the Crusaders, was breached by engines casting stones. At that siege, also, a single stone from one of King Richard's mangonels was known to kill twelve men of the garrison.—*Vinsauf.* In one of the English sieges in Scotland, the carcases of dead horses were cast into the town from the besiegers' engines. So also Froissart tells us (book i. ch. 106) that the French, besieging Auberoche, having caught an English messenger, tied his letters round his neck, thrust him into one of the machines, and shot him into the fortress.

[‡] So late, however, as 1453, we find the Turks, at the capture of Constantinople, using the ancient towers and battering-rams in combination with heavy artillery.—Gibbon, ch. 68. See also the remarks on the siege of Steinwyck in NOTE S.

[§] See NOTE Q, Peter Navarre.

[||] Froissart, book ii. ch. 87.

As the works of approach drew near the place, the saps appear to have been either *blinded, i. e.* roofed over with musket-proof timber, or masqued at short intervals by wooden frames (called *chandeliers*) filled with fascines, placed from side to side athwart the trench, which passed beneath them, or placed in advance of each other in direct *echelon.*‖ But for these we see substituted, as early as 1629, in the attack of Bois-le-

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* See an example at the siege of Groll, (Plate VII., fig. 101.)

† As in the attack of Groningen in 1594, shown in fig. 100, Plate VII.

‡ See vignette at the end of the book.

§ See NOTE S, Sir Francis Vere.

‖ Both of these methods are indicated in fig. 100.

Duc by Prince Frederic Henry, a regular double sap, with overlapping traverses, exactly such as is now taught in our military schools.* On the crest of the glacis we find counter-batteries against the flanks, as well as breaching batteries. Breaches were, however, generally completed by mining; the gallery of descent into, and the passage of the ditch, accomplished very much in the manner still taught—the latter, however, being blinded as well as the former.† The works of actual attack bore no proportion to the auxiliary lines of circumvallation. On these, vast labour was expended. Those of the Princes of Orange we find fraised and palisadoed with imposing relief and double ditches, and flanked at intervals, not by mere redans, but by bastioned forts, hornworks, and crown-works.‡ It seems to have been usual partially to employ the peasantry on these works. At the first investment, they were set in large numbers to dig a ditch roughly marked out round the place, and meantime the engineers traced the elaborate niceties of the proper circumvallation within.

The Turks, who, like other half-barbarous nations of the East, had an instinctive skill in works of intrenchment, as well as vast armies to carry them out, had long been in the habit of employing zigzags of approach, and extended trenches, parallel to the besieged fortress, as places of arms for the support of the attack. These latter were sometimes multiplied to an enormous extent, as at Candia, (1669,) and at their memorable attack on Vienna in 1683.*

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* *Dan. Heinsii Historia,* (1629,) which contains an interesting plate of this double sap, (p. 103.) See in NOTE R, an extract on ancient Indian sapping.

† These galleries, and similar works, were usually executed on contract by the engineers, who seem to have borne all risks of damage by the enemy, and to have forfeited a sum for every day's delay in the completion of the work beyond the stipulated time, whilst they received a bonus for every day gained on that period. "That same night," says Lithgow, "the Scots began their gallery, whereof one James Lecky was chief workmaster, who was to have for perfecting the same 36,000 gilders."—*Experimentall Discourse of this last Siege of Breda.* 1637.

‡ Frederic Henry's double lines round Breda (1637) each exceeded 18 miles in extent. "By which," Lithgow says, "Breda stood in the centre like a Maypole in a market-place, or like to a Theefe in a common hall condemned to dye." Spinola's circumvallation of the same city (1625) had 52 miles of parapet, the contravallation 16 miles, flanked by 96 redoubts, 37 forts, and 45 batteries. At Bois-le-Duc (1629) the entire extent of Frederic Henry's works was nearly 70 miles.

Probably Vauban took from the former siege, with the circumstances of which he must have been familiar, aided as the garrison had been by French detachments, the hint of the extensive parallels which he employed with such complete success at Maestricht in 1673.† These he continued to improve and methodise, combining with them zigzag approaches on the capital, the systematic use of vertical fire, trench cavaliers to drive the defenders from the covered-way, (first used at Luxembourg in 1684;) and, finally, with ricochet,‡ (introduced at Philipsburg in 1688, matured at Ath in 1696,) which perfected his system of attack.§

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* See NOTE T, Turkish Engineering, &c. The Attack on Vienna is shown in fig. 103, Plate VII.

† Short parallel returns like those in fig. 102, but much closer together, were introduced by the celebrated Blaise de Montluc, at the siege of Thionville, in 1558—(Daniel's *Hist. de la Milice Fr.*, i. 568)—but extensive parallels also are occasionally met with previous to the siege of Maestricht. For example, in the plan of the attack on Edinburgh Castle, when held by Kirkaldy of Grange, in 1573, the batteries are established in a first parallel encircling the castle; and there is a distinct indication of a second in advance, from which musketeers are represented firing on the defences. But their importance was not appreciated; they formed no part of the regular system of attack, and were more generally omitted—great pains being taken in fortifying the batteries themselves against sorties, to which they were so much exposed from this want of extended protection on the flanks. Louis XIV. himself, who was present at Maestricht, speaks of Vauban's parallels as entirely new. "We advanced," he says, "against the place as if in line of battle, with great and spacious parallel trenches, from which the troops, issuing by means of the banquettes which lined them, could meet the enemy on an extended front. The governor had seen nothing like this before, although he had been in five or six besieged places. On those occasions, the trenches had been always so contracted, that it was impossible to make head against the most trifling sortie."—*Mémoires de Louis XIV.*, quoted by Allent in his *Hist. du Corps du Génie*, 108.

‡ Ricochet fire, still a novelty, is thus noticed at the siege of Turin, in 1706:—"The enemy erected a battery, shooting even with the ground.——This battery consisted of twelve heavy cannon, and their fire had a terrible effect on the place of arms, at the gate of Suza, and on the covered-way of the citadel. These pieces were of such a make that, with a very little powder, their shot reached our works, where, after they struck, they made frequent bounds, with so little noise, that it was a difficult thing to avoid them."—*Mil. Hist. of Eugene and Marlborough*, i. 218.

§ The series of figures in Plate VII. illustrates these remarks on the history

A greater use of vertical fire has been made in later sieges; but no substantial change in the method of attack has occurred since the days of Vauban; nor, probably, has it since been practised by any with such rapid and uniform success as distinguished the sieges of the great master. The use of enfilade by ricochet does not appear to have been rapidly adopted. In the sieges of Marlborough's campaigns, large masses of artillery, in direct battery against the place, formed the principal means of subduing the defences. And Montalembert remarks,* that at the siege of Bergen-op-Zoom, in 1741, not a single battery was laid down according to Vauban's principles, to which he attributes the length of time (62 days) the town was able to hold out. Ricochet was never practised by the British artillery in sieges until those in the last Peninsular war. This may probably have been in part due to a want of faith in this indirect manner of firing, such as Jones notices in the Portuguese artillerymen at Badajos, "who would not believe they were doing good in firing over the parapet, and preferred striking the wall whenever they could do so unobserved." But, indeed, this method of acting against the defences cannot be so efficient now, when it is anticipated and provided against by the use of traverses, as it was when first introduced. Against well defiladed lines it must be an aid merely to direct fire, and, combined with a powerful fire of shells, to search behind and destroy the traverses.†

We proceed to illustrate the steps of this process by describing a system of attack, mainly as laid down by Vauban, and as it continues to be taught, and *in its principles* to be practised, though, in the ever-varying circumstances of actual sieges, the exact steps and measurements also vary very widely.

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of attack. Fig. 100 is the attack on Groningen by Prince Maurice in 1594; fig. 101, that of Groll (or Groenlo, in Gelderland) by his brother Frederic Henry, with his English and French allies, in 1627; fig. 102, that of Hesdin, in Artois, conducted by Antony Deville in 1639; fig. 103, the Turkish attack on Vienna (1683;) figs. 104 and 105, Vauban's sieges of Maestricht and Ath; and fig. 106, the French attack on Antwerp citadel, conducted by General Haxo as engineer, in 1832.

* Preface to his *Fortification Perpendiculaire.*

† See Jones, note 33, on Enfilade Fire.

As soon as the investment is formed, and outposts are driven in as far as can be done, the engineers make a careful reconnoisance of the fortress, verifying and correcting such plans as they possess, until a pretty accurate survey is obtained. The site of attack is selected, and surveyed with more especial accuracy; the engineers making themselves thoroughly acquainted with its localities and landmarks, whilst, if possible, so conducting their observations that the enemy shall not become aware what side has been chosen for attack.

The Engineer and Artillery Parks, containing all the stores and ordnance necessary for the prosecution of the siege, are established in sites as convenient to the works of attack as can be, consistently with their absolute security from the fire and observation of the place; and the communications from the parks and camp to the trenches will be made easy and direct, so that the way can be readily found in darkness or rough weather.

The first work to be constructed is the *First Parallel*, (*a a.*)* This is a trench, which serves as a place of arms, to be occupied by the troops intended to protect the attacking batteries which are to be thrown up, and as a covered communication between those batteries when constructed. It is laid down parallel to the general outline of the fronts embraced by the attack, at a distance of 600 yards from the salients of the covered-way. Roads from the parallel to the rear are dug at the same time, to as great a distance as may be necessary to secure the communications from the fire of the place. Fig. 109 is a profile of the first parallel, fig. 110 of the communications to the rear.

When all things are ready for breaking ground, (as the commencement of the excavations incident to an attack is termed,) the engineers at nightfall trace the parallel by reference to points and landmarks, of which they have previously mastered the bearings—white tape being used to indicate the trace, and marks of white paper, with dark lanterns when necessary. The men of the working party may be posted at 5 feet apart; and they are expected to complete their portion of excavation, to a depth of 3 feet, and a breadth of 4, before daylight. Cover is thus provided, which enables the parallel to be completed to its full width of 10 feet during the light of the ensuing day. The parallel is usually extended about 50 yards beyond the prolongations of the extreme right and left faces bearing on the front attacked, and terminates in a curved return. Should the garrison be in such strength that a flank attack is to be apprehended on either first or second parallel, it will be proper to construct redoubts at the extremities for their defence, as at *r*, fig. 107.

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* Plate VIII., fig. 107.

Batteries against the place are usually commenced on the second night of the operations. They may be classed as *Enfilade*, *Direct*, and *Mortar* Batteries.

Enfilade batteries will be constructed to sweep all the lines bearing on the front attacked, when their prolongations can conveniently be embraced in the extent of the first parallel. Here we may observe an advantage to the defence which a fortress derives from being constructed on a polygon of a great number of sides; for, the greater the number of sides, the nearer will the general contour of several adjacent fronts approach to a straight line, the greater will be the number of faces bearing upon the site of works of attack, and the more widely must the parallel be extended to embrace all their prolongations—adding vastly to the amount of labour entailed on the besieger, and to the risk of injury from the sorties of an enterprising garrison. In fixing the position of enfilade batteries, the prolongation of one of the outer lines of the parapet to be enfiladed can probably be determined by the eye, and a line should be laid to mark it. The crest line of the battery will be at right angles to this; and a line parallel to the prolongation, at a distance on its inner side equal to the estimated thickness of the parapet, will mark the position of the first gun, which will therefore fire almost on the prolongation of the interior slope of the parapet. The remainder will be placed at the usual intervals, firing on the prolongation of the rampart. The same battery will serve for the guns enfilading both a rampart and the covered-way before it. Thus the batteries 1 2, 3 4, and 5, enfilade respectively the faces of ravelin A, and of the bastions C and B, as well as the covered-way before them. Enfilading batteries, when intended to fire by ricochet, consist principally of heavy howitzers.

Faces bearing on the attack, which cannot be enfiladed without an inconvenient extension of the parallel, must be silenced, if possible, by a direct fire. Thus, to meet the fire of the ravelins D and E, batteries 6 and 7 are traced nearly parallel to their faces, so as to fire directly on them. The position of both direct and enfilade batteries should be about 50 yards in front of the parallel, communicating with it by trenches.

Both direct and enfilade batteries must be backed by a powerful fire of shells from heavy mortars. These are sometimes placed along with the guns in front of the first parallel; but as their great range admits of their playing from points considerably in the rear, they may be placed at a greater distance, as *m m m*, fig. 107.*

As soon as the fire of the batteries has produced an effect on the defences of the place, the second parallel *b b* may be begun at 300 yards from the salients of the covered-way. It is usually commenced by *flying sap*—*i. e.*, by placing a line of gabions simultaneously, and filling them as fast as possible.†

The approaches connecting the first and second parallels, which have been before commenced as opportunity offered, are now finished at the same time with the second parallel. These advance on the capitals, where they are least closely exposed to fire, and where they interfere least with the fire of batteries in the rear. The outline is zigzag, so that no part shall be liable to enfilade. To insure this, the portions of zigzag between the first and second parallels are directed upon points 20 yards beyond the foot of the glacis of the salient which is most prominent on the flank of that on which the approaches are advancing. Between the second and demi-parallels, they are directed to the foot of the glacis, and beyond the demi-parallels to a point half-way up the glacis. In order to interfere as little as possible with the fire of batteries on the first parallel, the zigzags are confined between converging lines drawn, from points on the first parallel 70 yards on each side of the prolongation of the capital, to the salient of the covered-way. Each new turn of the zigzag overlaps the preceding one by a *return*, as it is called, of some 30 feet in length. This completely covers the head of the trench, and, at the same time, affords a useful nook for storing materials, &c.

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* Plate VIII. † The profile of the second parallel may be as in fig. 111.

Should the occupation of the second parallel interfere with the fire of the artillery on the first, new batteries must be constructed, and the guns advanced to them. On level ground, this will probably not be necessary for the ricochet batteries which fire at an elevation, but it will be so for the direct batteries, such as 6 and 7, (fig. 107.)

The extremity of the second parallel, if not defended by a redoubt, may be connected by a defiladed trench with the works in rear. When left unflanked and unconnected, it is said to be *en l'air*.

In all trenches intended to be occupied by troops, steps should be made on the reverse side, to facilitate egress. "From a neglect of keeping the rear of the trenches practicable at Badajos, fifteen men were killed and wounded by one shell, which fell into the parallel at the time of the relief of the parties." *

When the zigzags of approach are within 150 yards from the salient, it becomes necessary to provide cover for the close protection of the working-parties, and to take additional steps for clearing the covered-way of its defenders. For this purpose, portions of parallel, or *demi-parallels*, as they are called, are thrown out right and left from the approaches. (See *f f f*, fig. 107.) Where these intersect the prolongations of the covered-way, howitzers may be brought up to sweep that work with grape and case shot.

Hitherto a great part of the trench-work may have been executed by flying sap; but if the defence is at all vigorous, it becomes necessary to have recourse to the slow but surer advance of the *full* sap, in which the trained sapper, shoving the sap-roller before him, plants and fills only one gabion at a time, whilst his comrades, following methodically, widen and deepen the trench which he has begun. Any slackness on the part of the defence will, however, be taken advantage of by resorting to the flying sap as often as may be safe.

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* Jones's *Sieges*, i. 478.

At 75 yards from the salient, a third parallel is constructed, (*g g*.) Numerous light mortars placed in it incessantly shell the covered-way and outworks. To facilitate the advance of the guards of the trenches, to meet sorties, &c., at intervals, the parapet of the parallel is broken into steps on the inner side, (fig. 112.)*

As the works of attack approach the place, it is obvious that the angles of the defiladed zigzags will become more and more acute, and less and less advance to the front will be made by the same amount of excavation. Where the salients of the fortress are very much in one line, as in a decagon or other high polygon, this inconvenience will be the sooner developed. When it becomes so great that the trench does not advance more than one yard to the front for every three yards of excavation, recourse should be had to the double sap, in which defilade is obtained by a succession of traverses projecting from the right and left parapets alternately, so as to *lock* or slightly overlap each other, or by excavating the sap so that it winds round both sides of masses of earth left isolated at proper intervals.

After the completion of the third parallel, should the fire of the batteries have been already so effective as completely to subdue the active defence and greatly to weaken the garrison, the covered-way may be carried by assault, and a lodgment on it effected by flying sap. But in ordinary cases the safe and sure process will be to advance up the glacis and along its crest by regular sap, clearing the covered-way of defenders by a fire of shells and musketry from trenches with elevated parapets. At Cambrai, in 1677, when the approaches had reached the glacis of the citadel, the ravelin was stormed contrary to the advice of Vauban, without crowning the covered-way *en règle*. The garrison brought a heavy fire on the work, sallied in force, and recovered the ravelin with great loss to the French. The attack was renewed by regular approaches, and the disputed work gained with the loss of five men. "I will believe you another time," said the King to Vauban.† But the latter was never bound by system. In the siege of Valenciennes which immediately preceded that of Cambrai, by his advice, in opposition to that of all the marshals, a crownwork was stormed in daylight; the troops forced their way into a ravelin which was covered by the crownwork, and thence pursued the defenders into the *Paté*, a great irregular work in rear. Still the French pressed on, forced the barriers of a vaulted passage to the enceinte, established themselves in the houses adjoining the ramparts until they were supported, and the place surrendered.* Similarly, at the capture of Charleroi by Saxe's army in 1746, a small detachment of troops on duty in the trenches at daylight pursued part of the garrison from the covered-way into a small hornwork connecting the fortress with the lower town, the drawbridge in the confusion not having been raised. The noise and alarm of this unexpected event drew off the attention of that part of the garrison opposed to the south attack, and they abandoned the front, conceiving themselves to be assailed in the rear. The French troops availed themselves of these circumstances without waiting for any orders, and got possession of the ramparts of the place.† Somewhat in like fashion, the strong fort of Monjuick was taken by Lord Peterborough (1705,) leading to the fall of the city of Barcelona at the commencement of the War of Succession.‡ Where mines were apprehended, Vauban generally preferred an assault by force to the more tedious operations by sap.

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* Plate VIII.

† Allent, *Hist. du Corps du Genie*, p. 141.

In advancing from the third parallel, single saps break from points 30 yards on each side of the salient, curving inwards up the glacis till they meet on the capital. The approaches then proceed on the capitals by double sap. Should the artillery not by this time have put an end to active measures of defence, it may be necessary to construct demi-parallels for the close protection of the work, and *trench-cavaliers* to complete the clearance of the covered-way. These cavaliers (fig. 113)§ are lofty parapets with stepped banquettes raised so high as to enable the assailants from them to pour musketry into the covered-way over the crest of the glacis. They are, as may be judged from their profile, very troublesome to construct, and should be unnecessary if a fair use has been made of mortars and howitzers from the advanced parallels.

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* Allent, *Hist. du Corps du Genie*, p. 139.

† Sir J. C. Smyth's *Chron. Epitome of Wars in the Low Countries.*

‡ Macaulay's Essay on that War.

§ Plate VIII.

The covered-way being cleared, the sap advances to the crest of the glacis; when, branching right and left, a lodgment is excavated embracing the contour of the glacis before the whole of the attacked faces. This is called the *crowning of the covered-way*. As the fire of the gun-batteries in the rear has in these latter operations become hazardous to the advanced guard and working-parties, vertical fire must be mainly depended on for preventing the revival of active resistance from the ramparts of the place. Marksmen, too, will be planted behind loopholes of sand-bags in the crowning lodgment, to keep a constant watch on the enemy's embrasures and parapets. Meantime, embrasures are cut through the parapet of the lodgment for the establishment of breaching batteries (Nos. 8, 9, 10, 11, 12,) against bastions and ravelins. *Counter-batteries*, also, (Nos. 13, 14,) must be constructed at the salient place of arms before the attacked bastion, to destroy the flanks which bear upon its faces, as they, from their situation and shortness, have been less liable to enfilade, whilst, as long as they retain any capacity of action, the storm of the breaches would be very perilous.

Whilst these batteries are being constructed, and are performing their work of demolition, galleries of descent into the ditch are excavated by miners, or ramps formed by blowing in the counterscarp with gunpowder.

Where the remaining defences consist of bastion and ravelin without interior retrenchments or redoubts, the ravelin would be taken by the regular advance of the sap across the ditch, and establishment of a lodgment by sappers on the breach, under a redoubled vivacity of fire from the trenches on the crest of the glacis. The breach or breaches in the bastion would then be stormed. Should there be an interior retrenchment with revetments, the sap must advance up the breach, and a battery be established on the rampart for its reduction.

It is to be noted that, in Vauban's system, any retrenchment within the bastion may be turned by establishing a battery (as No. 15) to breach the curtain through the *trouée* of the tenaille.

The tenaille itself affords little active defence, and it is not necessary to occupy it.

A wet ditch adds considerably to the difficulties at this stage of the operations, but we cannot enter here into the modes of effecting a passage. Many have been proposed, and a few have been practised. Probably, after the flanks have been effectually counter-battered, Blanshard's light pontoon bridge might be *boomed out*, from a breach made by mining in the counterscarp, to the breach in the ravelin or bastion.

Fortresses are very frequently provided with a system of subterraneous galleries beneath the covered-way and glacis, by which the garrison are enabled to spring *counter-mines* under the works of the besiegers. These must be met and destroyed by mining on the part of the assailants. This mining and countermining, of course, greatly varies the progress of the latter stages of the attack, but we cannot here enter into details of this underground warfare.

It was long supposed that the destruction under ground produced by a mine could not extend to a distance much greater than the *line of least resistance*, or depth of the charge from the surface nearest vent. But Belidor* proved by experiment that with large charges *craters* could be produced, the radius of which on the surface was nearly three times the line of least resistance. This discovery simplifies the attack of countermined systems, and gives a decided advantage to the besieger in such warfare. For the defender cannot resort to similar overcharges, as they would overwhelm his own galleries; so that the contest is between a long sword and a short one.

Instead of using artillery to open a gap for a storming party, breaches have often been made by what is called "attaching the miner to the wall." Miners, in this case, are sent across the ditch secretly, or under the protection of an overwhelming fire from all the trenches, to excavate a gallery and lodge a charge of powder under the rampart of the place. By this means Bhurtpoor was breached and captured in 1826.

Near the flanks of the first parallel, epaulements † are constructed to cover bodies of cavalry, kept in readiness to act against sorties, if there are no natural irregularities sufficient to afford them cover within a convenient distance.

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* See NOTE V, Belidor.

† *k, k, Fig.* 107.

CHAPTER X.

RETRENCHMENTS AND ADDITIONAL WORKS.

> **"The Platæans —— beginning at either end, where the wall was of its original height, built another in the form of a crescent running inwards into the city; that if the great wall were taken this might hold out, and their opponents might have to throw up a second mound against it, and, as they advanced within, might have double trouble, and be more exposed to missiles on both their flanks."— THUCYDIDES, ii. 76, (Dale.)**

1. In the construction of Vauban's first system, which we have laid down, we have described no retrenchments or interior defences requiring to be captured, in addition to the main works of ravelin, bastion, and covered-way. Though these do not form any essential part of the system as it is taught, there

is nothing in the trace which precludes their being grafted on it, either as permanent works, or as field-works thrown up during the progress of a siege, to cut off breaches or other weak points from the body of the fortress.

In outworks and empty bastions, the simplest form of retrenchment is a ditch cut at right angles to the face of the work, through the parapet and terreplein of the rampart on either side of the attacked salient. This is most easily applicable where a perpendicular wall occupies the place of the interior slope of the rampart. Otherwise, when the retrenchment is called for, that slope must be scarped and revetted with timber.

A lofty work called a *Cavalier* is sometimes constructed in the interior of full bastions, having a command of fire over the rampart of the bastion. Its object is to have full command of ground which would otherwise be imperfectly seen from the ramparts, or to aid the defilade of the fortress from adjoining heights. Cormontaingne, speaking from his own experience, says that, in the attack of places provided with cavaliers, they always caused him great difficulty in defilading his approaches, and annoyed the troops in the trenches much by their plunging fire.* In old places, these works were frequently constructed in the middle of a long curtain, as well as on the bastions. Where the cavalier in a bastion is provided with a ditch before its rampart, cuts similar to those just described may be made from its ditch across the ramparts of the bastion, thus isolating the two faces and salient under the fire of the cavalier. This is called a *Cavalier Retrenchment.*

In a full bastion without a cavalier, a *tenaille retrenchment* is sometimes constructed by running two parapets inwards from the shoulders, so as to form a re-entering angle in the middle of the bastion. Or, in a large bastion, this may be broken into the form of a small bastioned front. In all these retrenchments, though the cut extends through the parapet of the bastion, the escarp of the latter is left of the full height. The objection to them all is the extent to which they cut up and cramp the space available for the movements of troops and guns in the earlier stages of a defence.

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* *Fortification Permanente,* chap. xi.

The bastioned retrenchment may, however, if there is interior space, be drawn across the gorge instead of between the shoulder angles. Or, the retrenchment may be a straight line across the gorge, or two faces in the alinement of the adjoining curtains, meeting in an obtuse salient, so that their ditches may receive a flanking fire from the flanks of the collateral bastions. As we have shown, however, that in Vauban's system a part of the curtain is liable to be breached through the *trouée* of the tenaille, it will be better to embrace so much of the curtain in any proposed retrenchment, or to complete the isolation of the breaches by cuts across the rampart of the curtain on either side, scarping the interior slope of the rampart between them.

The retrenchment often consists of a stockade, or loopholed wall, instead of a parapet. So at the siege of Maestricht by the Prince of Orange, (William III.,) in 1676, "when we were in possession of the Dauphin Bastion, the enemy fired most furiously upon us with their small cannon through a thin brick wall, by which, and their hand-grenadoes, we lost more men than we did in the attack itself." *

A retrenchment sometimes cuts off a much greater portion of a work than a single bastion. Thus at Turin, during the French attack of 1706, the citadel was cut right across the middle by a retrenchment separating the attacked bastions from those on the side of the town.†

Of retrenchments generally, Vauban says, that they ought to be made, not on the spur of the moment, but with deliberate foresight; that they should be well revetted, with spacious ramparts, capable of mounting guns of the same weight as the enceinte, with shot-proof parapets, revetted counterscarps, and counter-mines, with all necessary communications; and that they should be so traced as not to interfere with the free use of the flanks and faces before them.‡

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* *Memoirs of Captain Carleton.*

† *Mil. Hist. of Eugene and Marlborough,* i. 205.

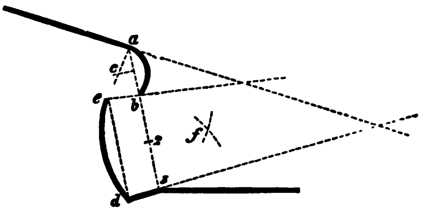
‡ *Defence of Fortresses,* quoted by Cormontaingne.

2. Most important places are furnished with *casemates.* These are bomb-proof vaults, constructed under the rampart of the bastions, or elsewhere, to afford barrack accommodation for the garrison, and an additional fire upon the ditch, through embrasures pierced in the escarp. Good casemated flanks, being protected from enfilade and vertical fire, are of great importance to the defence of the ditch; and it is a disadvantage of Vauban's tenaille that it precludes the use of casemated artillery on the flanks of the bastions. General Haxo, an eminent French engineer, who directed the attack of Antwerp citadel in 1832, has proposed a species of casemate for the protection of guns on the terreplein of the rampart. Guns in battery, hospitals, &c., are frequently protected from vertical fire by timber bomb-proofs as a substitute for casemates. These are called *blindages.*

In many of Vauban's works, and in older fortresses, bastions were constructed with *orillons* and *retired flanks.*

The orillon was a round tower or curved projection at the shoulder of the bastion, intended to conceal and cover the flank, which is usually concave. Cut 6 shows one form of this construction. The orillon *a b* occupies $\frac{1}{3}$ of the length of the flank, and its curve is tangent to the face at the shoulder angle. The chord *e d* of the retired flank is 10 yards in rear of the originally traced flank. Its length is determined by two lines, *b e* and 3 *d*, the first drawn from the salient of the collateral bastion through the extremity of the orillon, the other being the line of defence produced beyond the curtain angle. The segment *e d* is one-sixth of a circle, *b e* is called the *reverse of the orillon*, and there is generally a passage through this to the bottom of the ditch; *d* 3 is called the *brisure of the curtain.*

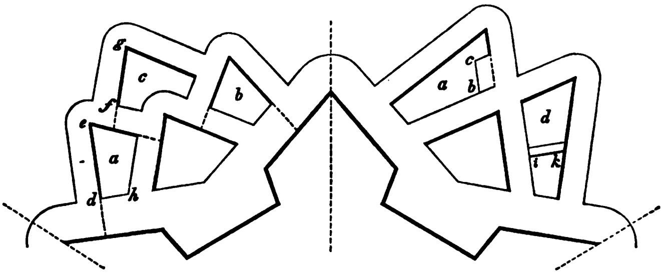
Cut 6.



When Vauban employed the orillon, the faces of his ravelin were directed on the shoulder angles of the bastion, and the salient was determined by the intersection, with the prolonged perpendicular, of an arc described with the curtain angle as centre, and the distance from the curtain angle to the opposite shoulder as radius.

3. Various additional outworks, or advanced works, have been constructed, with the idea of adding to the defence, or of occupying ground which it has been judged undesirable to leave to the enemy. *Hornworks* and *crownworks* have been already defined. They are placed covering either a bastion or a ravelin, and were used profusely in the larger fortresses of the Low Countries. At Tournay, for instance, in the old plans, almost every alternate front is covered by a large hornwork. Sometimes these are doubled and tripled, one before another. The cut below shows some other varieties of outwork which have been added to the ravelin, and which, as they exist in actual fortresses, it is desirable to mention, though their benefits are very questionable, requiring, as they do, large garrisons, affording little opposition to an enemy's lodgment before their salients, facilitating his breaching the bastion by the duplication of their ditches, and affording ample spaces, when captured, for his lodgment. On the right front *d*, *d* are *tenaillons*, with a retrenchment *i k*. The long branches are perpendicular to the faces of the bastions. On the left front, *a*, *b* are *demi-tenaillons*, sometimes called *lunettes ; c* is called a *bonnet*. Vauban, though the inventor of tenaillons, himself abandoned their use.

Cut 7.



Counter-guards are narrow additional ramparts rising out of the ditch, parallel to the escarp of the bastion or ravelin, which they are intended to protect from breaching. Sometimes the counter-guards form a continuous envelope enclosing several fronts. At Floriana, the suburb which protects the landward approach to Valletta, (Malta,) we find two large bastioned fronts, with their ravelins, covered by such a continuous envelope, which also has its ravelins. Before this envelope is a hornwork covered by a crownwork, and that by a lunette and covered-way, with spacious places of arms. The force of outworks could no further go! Yet this whole system is itself only an advanced-work to Valetta, which has its own covered-way, ravelin, envelope, giant bastions and cavaliers rising in the rear.

CHAPTER XI.

THE DEFENCE OF A FORTRESS.

> "Pendant huit mois qu'ils resterent devant la ville il n'y eut sorte de stratagemes que l'on n'inventat, ni d'actions de valeur que l'on ne fit, a l'assaut pres que l'on n'osa jamais tenter. Tant un seul homme et une seule science ont de force dans quelques occasions quand on sçait les emploier a propos. Otez de Syracuse un seul vieillard, avec si grandes forces sur terre et sur mer, la prise de la ville est immanquable: et sa seule presence fait que l'on n'ose pas meme l'attaquer, au moins de la maniere qu' Archimede pouvoit empecher."——POLYBIUS, (Folard,) viii. 4.

No service can be more trying to soldiers, or requires troops of a higher quality, than the prolonged defence of a fortress, where they are girt in by their own walls and ditches, as well as by the investing enemy; where offensive movements, unless on a petty scale, can rarely be effected; where, day after day, the assailant's progress is visible; where, though the garrison may resolve that he shall pay dearly for success, they scarcely can hope to be able to wrest it from his grasp.

And as no duty can require, on the part of a chief, a greater degree of energy, prudence, patient fortitude, and readiness of resource, so none is more deserving of honour, when worthily executed. It may usually be true that the absolute defeat of a besieger, who enters on the operation with sufficiency of means and complete mastery in the field, is beyond hope. Even against such resources an energetic defence may cause great damage and insure great objects; but, moreover, in many cases an attack may be undertaken where the besieger's mastery of the field is not undisputed, or his means not sufficient. Such cases were nearly all the sieges undertaken in the Peninsula by the British army—twice unsuccessful at Badajos, and again at Burgos; and in such a case occurred the memorable defence of Tarifa against the French.

The requirements of a good defence are suggested by the various steps of the siege—a parry for every thrust—but scarcely admit of such accurate description as the works of attack. The latter, in every regular siege, will have a substantial resemblance, and admit of dimensions, &c., being prescribed with more or less amplitude of margin. The former consist rather in the general exercise of the military virtues, and tactical skill to use rightly all the arms and resources of the service. This little work would, however, be incomplete without some sketch of the usual measures of defence.

When a siege is probable, it will be the duty of the governor personally to verify the condition and amount of his stores, and to see that they embrace not only food, ammunition, and medical necessaries, but gabions, fascines, timber, iron, cordage, nails, tools, and the like. He must be supposed already to have made himself thoroughly acquainted with his fortress and its environs, its weaknesses and capabilities, in great detail, taking account especially of the amount of bomb-proof cover which can be obtained, the facilities of creating inundation, the nature of communications with outworks and within the ramparts, the circumstances which, by any possibility, may assist surprise, such as the existence of open drains, &c.* Where the works are surrounded by wet ditches or intersected by rivers, he will provide rafts for communication, and see that the channels of the latter be barred by booms and stockades, and, in frost, the ice kept broken. In foggy weather, close chains of sentries must be posted in, or beyond, the covered-way, and a rigid inspection made of all persons and waggons entering the place. If the front of attack be determined, as in many cases it will be, by the nature of the ground, then traverses, blindages, and retrenchments will be constructed, and materials assembled in convenient depôts. The fortress should be divided into distinct charges, each placed under the superintendence of an officer, who will study its peculiarities, and take every precaution against surprise.

When a siege is actually determined on, the first measure of the besieger has been stated to be *investment*, for the purpose of barring communication, and the conveyance of supplies to the place. The counter-movement on the part of the governor will, of course, be to retard this investment, and prevent its being completed by surprise, so that he shall have time to recruit deficiencies in his garrison and stores, and defer the commencement of the siege as long as possible. To this end he will destroy the fords, bridges, and communications generally, by which the enemy must advance; he will clear the country of supplies to as great a distance as his means admit, occupying, in favourable circumstances, with field-works and light artillery, positions on the routes of access, from which he can annoy the enemy's advance without compromising the retreat of his own parties; and he will keep patrols constantly on the alert in every direction.

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* Entering by an open drain through the house of a friendly priest, Eugene surprised Cremona in 1702, and all but captured it. The enterprise failed from want of support, which was cut off by the destruction of the bridge over the Po. The allies, however, carried off Marshal Villeroi, the incompetent commander-in-chief of the French. His soldiers celebrated the double event in a song:—

> " Français, rendons grâce à Bellone,
> Notre bonheur est sans égal;
> Nous avons conservé Crémone
> Et perdu notre général!"

Meantime much work will be required within the fortress. Taking for granted that the masonry has been kept in good repair, still the earthen slopes will have been affected by time and weather, the crests degraded, the interior slopes worn and slouching, the banquettes and barbettes obstructed. These must be looked to, recut and repaired, so as to be again perfectly adapted to their purposes.* Palisades and barriers, if not already existing, will have to be erected on the covered-way, and barbettes for field-guns thrown up at its salients. All cover for the enemy within cannon-shot will, as far as possible, be cleared away.

When the investment is accomplished, the efforts of the garrison are next directed to obstruct reconnoisance, and to ascertain (if it be doubtful) on what side attack is intended. For these purposes, wall-pieces and field-guns are placed on the most prominent and elevated points, to fire on reconnoitring parties; small detachments are thrown out at night to a distance of 800 or 900 yards, who lie flat on the ground, and listen to every sound—on their return, in the daylight, endeavouring, with their narrowing circle, to intercept any reconnoiterers who may have passed within the chain; screens of cloth may be put up before the faces and salients, so as to conceal the true contour, and perplex the enemy's engineers in their determination of prolongations and distances;† and all means are taken to discover the exact position of the enemy's depôts, from which a judgment may be formed of the quarter to be attacked. When ground may be expected to be broken, a discharge of light-balls is kept up from all the mortars available; and as soon as the front of attack is ascertained beyond doubt, the besieged proceed to erect traverses and cut embrasures on that side; to arm and retrench the outworks; perhaps to throw out flèches beyond the glacis. As many guns as possible on adjoining fronts are brought to bear on the site of attack, by cutting oblique embrasures. When the enemy are actually opening their trenches, the governor will direct on the position of their working party the heaviest fire possible, bringing every movable piece to bear on that side of the place; running out field-guns, with the view of enfilading the work; driving off and harassing the workmen, by sorties of small bodies of horse rapidly advancing, sweeping along the front, and retreating.

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* Some engineers recommend that the interior of parapets, when constructed, should be left in a long slope, so as to include the whole space required for the banquette, and, when siege is threatened, the latter should be cut out of the solid mass. The superfluous earth resulting will be most convenient for repairs, and the construction of traverses, &c.

† Such screens might be so useful on many occasions of both attack and defence, that it is surprising they have not been oftener employed. Sir J. Jones mentions somewhere, that at Badajos the British engineers extended a canvas screen to cover an unfinished boyau; and the French, mistaking it for an earthen parapet, suffered the excavation to be completed without molestation. Similar screens were used at Gibraltar to mask a thorough repair of the batteries overlooking the Neutral Ground.—Drinkwater, chap. vi. They are recommended also by Albert Durer and Maggi in their treatises on Fortification. See NOTE L.

During the construction of the besieger's batteries, the defender concentrates his fire on them and on the capitals of his own works, (where the approaches will be in progress,) not wasting ammunition in a diffused fire at the completed parallel. When the commencement of the second parallel may be expected—ascertaining, by means of light-balls, if work is going on—he keeps up a fire of grape and musketry from the covered-way. At this period, or earlier, the ground may admit of his running out a trench of counter-approach, from which the enemy's places of arms or zigzags may be enfiladed, without its being liable to enfilade in return. And now, when the use of gabions by the besiegers begins, the effect of sorties, accompanied by working parties to destroy the labours of the night, will tell most on the duration of the siege.

It is to be remembered that sorties, under the circumstances of a well-designed attack and proper vigilance on the part of the besieger, are to be considered only as "the best and surest expedient for interrupting and delaying the works of the attack, and consequently of retarding the fall of the place," not as desperate assaults on the trenches of the enemy, with the idea of putting their guards to the sword—contests in which success could only be momentary, and the probable loss to the garrison would be more detrimental to them than any, even though numerically much more severe, which they might be able to inflict, would be to the besiegers.* Hence, in general, sorties ought to be small, frequent, and rapid, both in advance and retreat, unless where a movement on a larger scale may effect the destruction of an important work, by which the operations of the siege will be seriously retarded, or where the ground is so contracted by inundations, &c., as to put the two parties on an equality. In cases where powerful and deliberate sorties have been able to strike a great blow, and come off completely victorious, there will generally be found special circumstances to account for such success. So, at Gibraltar, in the memorable sally of brave old Elliott with a third of his garrison,† on the 26th November 1781, when, with a loss of less than thirty killed and wounded, he annihilated works which had cost the besiegers months of labour, and spiked some thirty pieces of heavy artillery, special reason for success may be found in the long duration of the siege without any previous attempt of the kind, so that the Spaniards were surprised and panic-stricken, as well as in the limited field presented by the Neutral Ground, which did not afford the besiegers that power of concentrating numbers from extended parallels, which would exist in ordinary cases of attack. However, sieges will often be, as they have been before, imperfectly conducted, and opportunities will occur to garrisons of striking a vigorous blow at an assailant whose trenches are insufficiently developed or negligently guarded, or whose arrangements for defence are ill organised. To such causes as these may be attributed the undeniable success of six out of eight powerful sorties made by the French garrisons during our sieges in Spain. "The events of these sieges show, that a bold and vigorous sortie in force might carry destruction through every part of a besieger's approaches, where the guard is injudiciously disposed and ill commanded; but that, if due precautions have been observed in forming the approaches and posting the defenders, any sortie from a besieged place must be checked with loss in their advance, when the approaches are still distant; or, when the approaches are near, should a sortie succeed in pushing into them by a sudden rush, the assailants must inevitably be driven out again in a moment with terrible slaughter." *

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* See Jones, ii. p. 163.—"Notwithstanding that sallies out of a town be sometimes necessary, yet are they very dangerous for those that defend the place—for the loss of ten men is more to them than of a hundred to those that besiege them; first, because their number is not equal; secondarily, because they cannot put men into the town at their pleasure; and lastly, because haply they may lose one of their chief captains, which mishap causeth oftentimes the loss also of the place."—Philip de Comines, book ii. chap. 11. (Trans. by T. Danett, 1596.)

† Drinkwater, chap. v.

As the enemy now advances by sapping, every effort should be made to maintain a fire of round-shot, as one or two pieces of field-artillery, directed on the head of the sap, are quite sufficient to stop its progress. These should be aided by marksmen posted in the covered-way, firing through loopholes of sand-bags. Blinded batteries should also now be prepared by night on the salients of the ramparts, and counter-mines under the glacis.

When the works of the third parallel are completed, the garrison must be ready to meet an assault on the covered-way. They should not, unless decidedly successful, maintain the salients so long as to risk their being mingled pell-mell with the assailants, but retreat, under successive volleys from the traverses, to the re-entering places of arms, leaving the enemy exposed to shells, grenades, and grape from the place, and to musketry from the ravelin.

Should the glacis be crowned by regular sap, whilst this is in progress, the defenders must keep up such fire as they can from mortars, pierriers, and the blinded salients, aided by mines, and these followed up, when sprung successfully, by rapid sallies on the saps. As the descents are in progress, a fire of heavy shells should be concentrated on their position, and guns, if possible, be brought to bear on their aperture into the ditch.

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* Jones, ii. Note 35.—" After the French had made one or two sorties at San Sebastian, with some success, on a parallel at about 200 yards' distance, the guard in the exposed part of it were made, during the night, to sit on the reverse of the trench with their arms in their hands, in expectation of the next, and under instructions to charge the enemy the instant they should be seen on the parapet. This accordingly took place, and it was driven in at once without an attempt at a struggle, and was the last attempt of the kind."—*Aide Mém.*, i. 89.

Efforts should be made to interrupt the arming of the breaching batteries—a slow and laborious process, especially in soft soil or wet weather.

When breaches are effected, the exertions of the governor are directed to clearing away the rubbish, covering the ascent, and the ditch at its foot, with artificial obstacles of every kind; aiming not so much to meet the assailants by a hand-to-hand struggle at the breach, as to check them there by passive obstacles, whilst he brings to bear on the spot a heavy concentrated fire from his retrenchments. The latter, if not permanent parts of the fortress, should be strongly stockaded, combined with loopholed buildings, or otherwise placed beyond liability to capture by a sudden rush. Otherwise, they cannot retard the fall of the place; they cause useless bloodshed, and had better be dispensed with.*

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* See an interesting note on the defence of breaches, by Sir J. Jones, vol. ii. Note 36.

CHAPTER XII.

THE "MODERN SYSTEM."

> "No longer strove blind rage with rage more blind;
> But in the enlightened field of skill was shown
> How fortitude can triumph over boldness,
> And scientific art outweary courage."——THE PICCOLOMINI, ii. 6.

In the erection of Béfort and Landau, on the Rhine frontier, between 1684 and 1688, Vauban introduced marked changes in his method of construction; and these were carried still further at New Brisac, about the end of the century. The constructions called Vauban's 2d and 3d systems have been deduced from these works. The characteristic of both is a polygonal enceinte, flanked by small casemated towers, or bastionettes, and these covered by detached bastions. At New Brisac, (3d system,) Vauban also greatly enlarged both bastion and ravelin, placing a strong redoubt, or inner work, in the latter.

After Vauban, the next great engineer who devoted himself to the advancement of the art, was Cormontaingne.*

What is usually taught under the name of the *Modern System* is mainly based on the improvements of Cormontaingne, modified by subsequent French engineers. Its main features of difference from the first trace of Vauban are,—

1st, The enlargement of the bastions, affording more space for artillery, musketry, the defence of breaches, and the construction of retrenchments on those works which are at once the most active in defence and the most liable to attack.

2d, The great salience and capacity of the ravelins, compelling the attack and capture of those works before the crowning of the covered-way in front of the bastion can be accomplished. This is *not* necessarily the case in Vauban's system, where the salients of bastion and ravelin are nearly included in the circumference of the same circle. Vauban's ravelin compels the besieger to use more means, for it must be reduced; but this need not be till all is ready for the attack of the bastion also, and therefore it adds little or nothing to the duration of the siege. In the modern system, also, the ravelin completely covers the shoulders of the bastions from batteries on the glacis before it. In Vauban, these batteries can breach the bastion so near the shoulder that the flanks are thrown open to enfilade. The salience of the ravelins, likewise, compels the besieger to open his first parallel at a distance too great for the effective ricochet of the faces of the bastions, and gives great protection to sorties.

3d, The ample size of the ravelins admits of the construction of redoubts within them, which must also fall before the bastion can be carried, their flanks bearing in reverse fire upon the breaches.

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* See NOTE V, Cormontaingne.

4th, The construction of redoubts within the spacious re-entering places of arms, which, in combination with retrenchments across the adjoining rampart of the ravelin, still further retard the completion of the crowning lodgments before the bastion. Thus five works must be captured before the breaching batteries against the bastion can be established.*

The revetments in this system are what is termed *counter-sloping;* that is to say, they are perpendicular on the outer side, and on the inner side expand towards the base. This expansion, instead of being made in a slope, is usually gained by a succession of steps or offsets. Demi-revetments are those employed, and a rectangular *tablette* takes the place of the rounded cordon, the upper side of which forms a sort of small berm, 2′ in width, between the foot of the exterior slope and the face of the wall. The counterforts are rectangular in plan. Sometimes the revetments are constructed *en décharge*—that is, with arches and backwalls between the counterforts. Doorways being left through the latter, thus galleries are formed behind the wall, from which, by loopholes, a fire may be brought on the ditches.

The main advantages of the modern system, from the salience of the ravelins, &c., will not be developed on a figure lower than the octagon.

Construction.†—The length of the exterior side is 384 yards;‡ the perpendicular, as before, is $\frac{1}{6}$ of this length.

The face of the bastion is $\frac{1}{3}$ of the exterior side, and the flanks are drawn perpendicular to the lines of defence. The rounding of the main ditch before the bastion is described as before, but the tangents which define the remainder of the counterscarp are drawn from the *crest of the parapet* at the shoulders of the bastions, not from the shoulder angle of the cordon.

The tenaille is 16 yards thick as before, but its ends, as well as its gorge, are 11 yards from the escarp of the enceinte. The crest of the parapet forms on each side a return or small flank perpendicular to a line drawn from the middle of the ditch of the Ravelin, at its intersection with the originally traced main counterscarp.

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* Viz., two ravelins and the redoubt in one of them at least, and the redoubts in the two places of arms.

† See Plate VIII., fig. 120.

‡ Equal nearly to 360 toises. See note, p. 85.

To construct the Ravelin.—Set off on the face of each bastion a distance of 36 yards from the shoulder. On the imaginary line joining these points construct an equilateral triangle. The apex of the triangle will be the salient of the Ravelin; its faces terminating, as in the former system, on the counterscarp as originally traced. The ditch of the Ravelin, and the Covered-way are traced as before; the latter 11 yards wide.

The faces of the Redoubt in the ravelin are parallel to those of the Ravelin, being directed on the crest of the parapet at the shoulders of the bastions. The counterscarp of the ditch of the redoubt is parallel to these faces, the breadth of the ditch being 11 yards.

To draw the Flanks of the Redoubt.—From the intersection of the face, with the originally drawn counterscarp of the main ditch, set off 11½ yards along the latter line, and 18 yards along the face. The line joining the two points so found will be the flank of the redoubt. The gorge of the redoubt will be a line joining the extremities of the crest of these flanks. The gorge of the ravelin is drawn parallel to the exterior side, 6 feet within it, to meet the flanks of the redoubt on each side.

To construct the Redoubt in the re-entering Place of Arms.—Draw its capital, bisecting the re-entering angle of the counterscarp before each face of the bastion. A line drawn from the salient of the bastion to the salient of the ravelin, intersecting this capital, will give the counterscarp of one face of the redoubt. A line drawn from the angle of the salient place of arms, through this intersection, will give the counterscarp of the other face. The escarps are parallel to these counterscarps, with a ditch of 6 yards wide between. A small flank is given to the redoubt on the side towards the ravelin, by making the crest only of the parapet, for a length of 6 yards, perpendicular to a line drawn from its extremity to the salient of the ravelin. By the prolongation of this latter line a triangular portion is cut from the interior of the redoubt, and added to the ditch of the ravelin.

The trace of the re-entering place of arms is circular. The arc is described from the original angle of the counterscarp formed by the ditches before ravelin and bastion as a centre, passing through a point on the capital of the redoubt, 20 yards beyond the counterscarp.

Traverses at each intersection of this arc with the outer edge of the covered-way complete the enclosure of the places of arms. There are three more traverses on each branch of the covered-way of the ravelin, the outermost terminating on the prolongations of the faces of that work. These last traverses have superior slopes of only 9 feet; those adjoining the place of arms being 18. The passages round the traverses are *en cremaillère*, or indented. The breadth of the glacis is 60 yards. At the salient place of arms before the ravelin, the angle of the crest of the glacis is cut off by a line 9 yards long at right angles to the capital.

There is a *coupure*, or retrenchment-cut, across the rampart of each face of the ravelin. It consists of a parapet, and a ditch 6 yards wide, the counterscarp of which is determined by a perpendicular to the face of the ravelin drawn from the extremity of the escarp of the redoubt in the place of arms.

The principal advantages sought by this trace have been already pointed out. A few of the minor peculiarities may be noticed. The *trouée* of the Tenaille, being masqued by the spread of the ravelin, the ends of the Tenaille may be removed to a safer distance, as regards splinters, &c., from the flanks, without fear of exposing the curtain to the enemy's lodgments on the glacis. The small flanks given to the parapet of this work serve to bring a musketry fire directly on an enemy entering the main ditch from that of the ravelin.

The ravelin being traced as an equilateral triangle has an opening of 60° only, the most acute which is permitted by the rules of experience. When several fronts of this system are in one line, this great salience of the ravelins completely covers the faces of the bastions from enfilade.

The ditches of the ravelin and its redoubt are both flanked by the face of the bastion, whilst the flanks of the redoubt bear directly on that part of the bastion, between the salient and the prolongation of the face of the ravelin, which is most liable to be breached. These flanks are intended to have guns in casemates, which would be completely protected till the fall of the redoubt itself.

By the construction of the redoubt in the place of arms, the ditch, on one face at least, is quite defiladed; the small flank bears directly on the usual site of a breach in the ravelin; and by the direction given to its demi-gorge on the side of the ravelin, the gorge communication is concealed from the enemy's lodgment before the salient of the ravelin.

The circular trace of the places of arms renders their banquettes less liable to enfilade.

The reduced thickness of the advanced traverses in the covered-way is sufficient to stop ricochet shot, but not to resist the direct artillery fire of the enceinte, should a besieger take advantage of their cover.

The *coupure* in the ravelin is intended to prevent the assailant from driving the garrison out of the redoubt in the place of arms, as soon as he captures the ravelin; and its ditch is so traced as to be defiladed by the parapet of the redoubt. It must be confessed that the former more important object seems, in the trace laid down, to have been somewhat sacrificed to the latter.

A difference of 8 feet between the level of the main ditch and the ditch of the ravelin serves to bring a greater part of the latter into view from the face of the bastion,* covers the communication with the place of arms, and is an obstacle to sapping towards the bastion.

The dimensions of parapets, &c., may be drawn the same as in the former system. The following are exceptions or additional:—

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* "I have heard General Filley relate that, at an attack which he conducted during the war in Flanders, between 1744 and 1748, he placed several companies of grenadiers in the ditch of a Ravelin, to wait the moment of assault; and that there they were entirely sheltered from the fire of the place, heavy as it was."—BOUSMARD, Sup., Book ii.

Enceinte,	Interior slope of rampart,	14′
„	Exterior slope of parapet,	11′
Berm, (in all the works,)		2′
Tenaille,	Exterior slope,	6′
Redoubt of ravelin,	Interior slope,	12′
„	Terreplein exclusive of banquette,	18′
„	Exterior slope,	5½′
Ravelin,	Do. do.,	6′
Redoubt in place of arms,	Interior slope,	5½′
„	Terreplein,	10′
„	Exterior slope,	3½′

The modern system is commonly drawn with permanent retrenchments in the bastions. For a gorge retrenchment, as recommended by Cormontaingne, take a point on each curtain adjoining the bastions at a distance of 20 yards from the angle of the flank. The line joining these points is to be the exterior side of the retrenchment. Make the perpendicular $\frac{1}{7}$ and the faces $\frac{2}{7}$ of this exterior side, and draw the counterscarp of the ditch to the shoulders of the demi-bastions so formed, from the angle of the flank of the original work. Where a cavalier is to be combined with a retrenchment, its faces and flanks will be parallel to those of the bastion. The faces having a ditch of 11 yards in front may be drawn at a distance of 23 yards from the crest line of the bastion, the flanks (without a ditch) at the distance of 12 yards from the same line. The intrenchment is completed by a *coupure*, or cut, at right angles through the parapet and terreplein of the bastion. The ditch of this coupure may be made 6 yards wide, and its counterscarp is drawn from the intersection of the produced face of the ravelin with the face of the bastion, so that the retrenchment cannot be turned by a breach effected from a battery firing along the ditch of the ravelin. That part of the parapet of the *coupure* which flanks the ditch of the cavalier is retired by a distance about 1 yard greater than the thickness of the parapet, so that from the interval so left on the counterscarp, some little fire can be directed on that part of the face of the cavalier which would otherwise be unflanked.

The total relief of the enceinte, excluding the cavalier, is 45½′, — viz., 23½′ above the plane of site, and 22′ below it. Other vertical dimensions are as follows :—*

Heights above Plane of Site.	
Enceinte Tablette,	8½′
(The escarp being consequently 30½ feet in height.)	
Tenaille, crest,	5′
Redoubt of Ravelin crest,	20½′
Ravelin,	17½′
Glacis before Ravelin,	8′ 4″
... ... Bastion,	9½′
Redoubt in P. of A., crest,	14′
Cavalier, crest, (may be taken),	32½′
... Tablette,	18½′
... bottom of ditch,	0′

Depths below Plane of Site.	
Ditch of Redoubt of Ravelin,	6′
... of Ravelin,	14′
... of Redoubt, P. of A.,	11′

Slopes of Terrepleins.	
Enceinte,	0½′
Tenaille,	1′
Terreplein Redoubt of Ravelin,	0½′
Interior of Redoubt, (upwards from the gorge),	1½′
Ravelin,	0½′
Terreplein Redoubt in P. of A.,	0½′
Interior do.,	1′
Covered-way,	0½′

There is a double staircase leading from the end of the caponière to the redoubt in the ravelin; and posterns descend from the latter to its ditch, under the flanks. The staircases at the re-entering places of arms communicate by a landing with the ditch of the ravelin. There are staircases likewise leading from the ditch of the redoubt of the ravelin to the parts of the ravelin behind the coupure. Close to the coupure, ramps lead up to the fore part of the ravelin. There are posterns from the redoubt in the place of arms to the ditch under each face, and ramps lead from the ditches into the covered-way.

A half caponière is sometimes made, covering the communication between the staircase at the gorge of the ravelin, and the postern under the rampart of the redoubt of the ravelin.

* See Plate VIII., fig. 121.

CHAPTER XIII.

BRIEF NOTICES OF SOME OTHER SYSTEMS OF FORTIFICATION.

> "Que le dur metier de la guerre
> Sera facilement exerce sur la terre !
> Quel progres fera Mars avec ses nourrissons !
> Toutefois quel progres, puisque tu fais entendre,
> Si l'on suit tes leçons,
> Que l'on peut prendre tout, et qu'on ne peut rien prendre !"
>
> DESMARETS, au Chev. Deville.*

COEHORN,† a Dutch contemporary of Vauban, proposed several systems specially adapted to the marshy soils and wet ditches of the United Provinces, instead of designing works as if for a dry ditch, and then supposing water to be admitted, without reference to the different requirements of the two cases. His plans embrace an outer system of wet ditches and unrevetted works, with an inner line of dry ditches and revetted works. The details are peculiarly complicated, and not to be understood without plans and long explanations.

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* Quoted by Allent.

† See Note W, Coehorn.

In the last century, Montalembert* started the idea of bringing a vastly greater power of artillery to bear on the attack, than any besieging army could bring into the field. For new constructions, he rejects the bastion trace altogether, substituting a succession of salient and re-entering right angles. The enceinte is covered by a double succession of counterguards, all flanked by casemated batteries of several stories at the re-entering angles. Great circular towers of masonry, four stories high, at the salients of the enceinte, command the whole. Bastioned fortresses, already existing, he proposes to modify by elevating and altering the tenaille, so as to convert the outline into a polygon of fronts *en tenaille*, to which the bastions act only as retrenchments. Flanking defence he procures by the construction of casemated caponières in rear of the ravelins. This may serve to give a general idea of the character of his projects; but his great work, *La Fortification Perpendiculaire*, contains a vast variety of designs.†

Under Napoleon, Carnot‡ published a new system, of which the main characteristics were, the substitution of a long slope (*glacis en contrepente*) for the counterscarp, in order to facilitate sorties, which he intended should assume an unprecedented importance in the defence; a detached and loopholed escarp wall,§ (which already had formed one of the details of Montalembert's projects;) and an immense amount of vertical fire from mortars placed in bomb-proofs on the capitals. The book is very interesting and valuable; but the exaggerated effect attributed to the combination of sorties, and showers of small shot from mortars, by which he proposes to kill off the besiegers in reliefs, reminds one strongly of Captain Bobadil's plan for the extermination of the Spanish army.*

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* See Note X, Montalembert.

† A method of obtaining a preponderance of power for the defence has been lately projected in an ingenious work by Mr Ferguson, an accomplished merchant of Calcutta, well known for his works on Architecture. A good idea of his system may be had from the description which Herodotus gives of the walls of Ecbatana:—"Deioces built lofty and strong walls, which now go under the name of Ecbatana, one placed in a circle within another; and this fortification is so contrived that each circle was raised above the other by the height of the battlements only—there being seven circles altogether."—Carey's *Herod.*, i. 98.

‡ See Note Y, Carnot.

§ A detached wall on the outer edge of the ditch, as an obstacle to escalade, is laid great stress on by Machiavelli, in his dialogue on the Fortification of Cities and Castles.—*Art of War*, book vii. chap. 1.

The novelties projected by Bousmard,† in the Supplement to his celebrated *Essai Général de Fortification*, consist mainly in the advancement of the ravelins beyond the glacis, the addition of casemated flanks to the tenaille, the reduction of the width of the ditch, so as to bring the covered-way within grenade-cast of the rampart, and the conversion of the traverses into small redans. These ideas are mentioned here because the first two, at least, were adopted to some extent by Chasseloup de Laubat, in the construction of Napoleon's great works at Alessandria in Piedmont — though these exist no longer.

On the new fortifications which have been erected in Germany since the peace, the ideas of Carnot and Montalembert, especially of the latter, have had considerable influence. The general principle is to enclose the space of ground, which has been selected for fortification on account of its important bearing on the great movements of war, by "self-contained" works occupying the most influential or valuable points, each provided with a strong interior redoubt and flanking casemates, so as to be capable of a vigorous independent defence. These are either connected together by a polygonal enceinte, or form advanced works, which must be regularly besieged and captured by an enemy before he can commence his attack on the fortified city, or central castle within. The works of the latter are constructed on the same principle of making all the main points capable of independent defence after the capture of the continuous rampart. Flanking defence is mainly derived from great masonry caponières, the lower guns of which sweep the bottoms of the ditches, whilst the upper tier commands the glacis. These caponières are covered by earthen works, great ravelins or counterguards, the ditches of which are flanked and shut up by casemated batteries.

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* *Every Man in His Humour*, Act IV., Sc. 5.

† See NOTE Z, Bousmard.

Blinded gun-batteries are placed on the salient parts of the rampart, and the casemated mortar batteries of Carnot on the capital behind them. Strong defensible barracks occupy the interior of each front in large fortresses, and smaller works have a central or gorge redoubt of masonry frequently acting at the same time as a cavalier, having a command over the enceinte and the ground before it. "The motives of the new fortification are principally the evident defects in the 'system of bastions,' which have been obviated by the introduction of independent and detached works; also of covered batteries, which cannot be destroyed from without; of bomb-proof places for the troops in the works themselves; and also in those positions where they are required for the defence, by the construction of advanced and detached outposts; and, lastly, by establishing practicable and safe communications for all movements of troops. If these principles have been the leading ones in the newly constructed works, still there has been no fixed system observed by us." *

The position of the great caponière, which is usually employed to flank the ditches of these works, being in the centre of the front, the length of the exterior side may be taken at twice that of the lines of defence, 600 yards or more. And the salients of the enceinte being identical with those of the polygon on which the work is traced, (not diminished, as in the bastion systems,) even in an octagon the faces are completely covered from enfilade by the ravelin, without an extravagant projection of the latter.

The following cuts illustrate the general principles of this German system in the works of Fort-Alexander, near Coblentz, as reduced to a geometrical construction by Colonel Humfrey. Its trace appears to be, in the main, a simplification of those laid down by Montalembert in the second volume of his great work.

The ground near Coblentz—a site of permanent importance in war on the Rhine frontier—has been selected for one of

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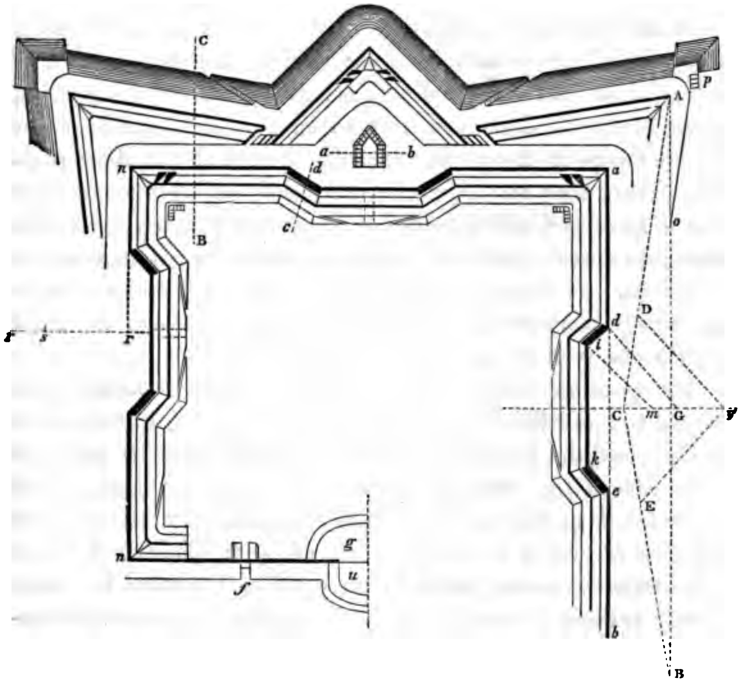
* Prussian Engineer Inspector Brèze, quoted in *Aide Mémoire,* vol. ii. 56.

those great intrenched camps, or spaces fortified to be the resort of an army on the defensive. Where the Moselle enters the Rhine from the west, Coblentz lies on the angle between the right bank of the Moselle and the left of the Rhine. A series of works, of the general character which we have described, occupies the heights on both sides of the Moselle, enclosing the angular spaces between it and the Rhine.

Cut 8.



The great fortress of Ehrenbreitstein covers a rocky hill on the right bank of the latter river, commanding both banks and the town below—the citadel of the system. The work of next importance is Fort-Alexander, covering the approach on Coblentz between the Rhine and Moselle.

In the figure (cut 8) *na* and *nn* represent the corresponding fronts of Fort-Alexander, which is constructed on a parallelogram obliqued 5° from a right angle: *ab* shows the mode of tracing a front with the dimensions of *na*. The following are the data:—

AB = 660 yards; GC = $\frac{AB}{12}$; CD, CE = $\frac{AB}{7}$; CF = $\frac{AB}{6}$;

FD and FE are the faces of the ravelin.

ab = 492 yards, parallel to AB at 81 yards' distance. *ad*, *de*, *eb*, each = $\frac{ab}{3}$. The casemated flanks *di*, *ke*, are each 33 yards long, being the chords of portions of circles described from G, with the radius G*d*. C*m*, = 29 yards, determines the salient of the caponière, of which the faces lie on the lines *mi*, *mk*. Its flanks are parallel to the capital at 16 yards on each side, and the gorge lies on the interior side *ab*. The ditch on the capital of the caponière is described with a radius of 20 yards; tangents directed on *d* and *e* complete its outline.*

The ditch before the bastions (if they can be called so) is 28½ yards wide, the counterscarp parallel to the faces. The faces of the counterguards covering the bastions lie on the lines AC, BC. The ditch before the counterguards and ravelin is 50 feet wide, with a countersloping glacis of 25 yards in width, instead of a counterscarp. Casemated batteries at D and E flank the ditches of the ravelin, and protect the faces of the bastions from being breached. The caponière has two tiers of casemates on each side, covered with earth, the middle open to the air. Before the salient of the counterguard (as at *p*) there is a portion of regular glacis extending on either branch for a space equal to the width of the ditch, and here is placed a casemated blockhouse of masonry. There are mortar batteries in casemates on the capitals of the bastions, and the gun-batteries on the salients are blinded: *gu* is a keep or inner casemated redoubt; *f* is the drawbridge and entrance to the fort.

The long lines of the work are defiladed by being directed on the neighbouring hollows.

BC (cut 9) is a section of the bastion and counterguard; *cd* of the flank; *ab* of the great caponière.

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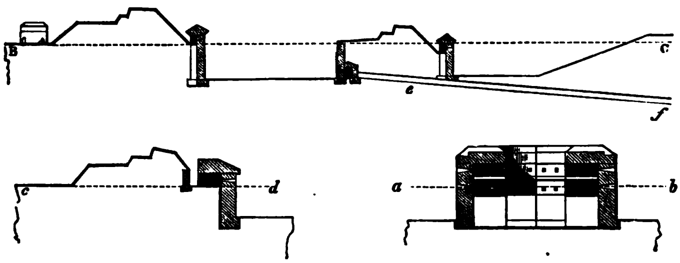
* The trace, as given in the *R. E. Professional Papers*, vol. ii., is somewhat different from this.

The crest of the enceinte is 25′ above the plane of site; that of the counterguard 11′. The revetments are partially detached, the upper part loopholed with a *chemin des rondes* of 5′ behind. A gallery for countermines runs round the whole work, with *listeners*, as they are called, (*ef*,) run out under the countersloping glacis. The bottom of the ditch is about 20′ below the plane of site.

Cut 9.



At Cologne, Mayence, and various other localities, works have been constructed, giving those places a character analogous to that of Coblentz—viz., that of intrenched camps defended by strong detached forts, and having the fortified city as a nucleus. The details vary considerably; but, in all the Prussian works at least, the spirit of Montalembert is discernible. At Lintz, on the Danube, the Austrians have fortified a great rallying point, enclosing the position with thirty-two circular towers.

A similar extensive use of detached forts is found in the modern defences of Genoa, Lyons, and Paris—in Lyons without, and in Paris combined with a bastioned enceinte. The French, whilst adopting some of the details of Montalembert, &c., have generally held to the principles of Vauban and his disciples in their outline.

This may serve to give an idea of the character of the changes which have been introduced in works formed since the end of the last European war. Still, for many years to come, by far the greater number of fortresses, which may have to be dealt with in attack or defence, will be works constructed on the old Bastion Systems.

APPENDIX

NOTE A.—SIKH INTRENCHMENTS.

IN the Sikh intrenchments generally, it appeared as if the position of the guns had been selected by some directing head, the batteries being planted with great judgment, and carefully revetted with timber, whilst the connecting and interior trenches had been left to the discretion and convenience of each battalion and group of fighting men, to cover themselves as they thought best. Thus the trenches were sometimes found to be line within line, eight or ten deep, as if a regiment in column had fallen to digging as it stood. Even in the extemporaneous position which Sher Singh took up at Sadoollapoor on the Chenab, (3d December 1848,) when he turned out of his camp, opposite Ramnuggur, to meet Sir Joseph Thackwell advancing on his flank, such excavations had been commenced during the few hours that the Sikhs were posted there. So also Capt. Cunningham describes their conduct when surprised on the march at Aliwal: "With that activity necessary to their system, and characteristic of the spirit of the common soldiers, they immediately began to throw up banks of earth before their guns, where not otherwise protected—such as would afford some cover to themselves, and offer some impediment to their assailants." * "We are again about to war on moles," said Marlborough's men, advancing on the French intrenchments at Malplaquet;† and the same expression was frequently heard in the armies of the Sutlej and the Punjab.

In the following extract, the proceedings of both parties will recall to many those of the Sikhs at Ramnuggur and elsewhere:—"The French began to dig a trench hard by Charenton, which ran in length to the very end of our camp, directly over against the which (the river being between us and them, as you have heard) they built a bulwark of wood and earth, and thereon mounted great store of artillery.——The trench was of great length, and they wrought continually upon it, casting the earth towards us, thereby to save themselves from our shot: for they lay all in their trench, neither durst one of them peep out, because the meadow where they lodged was as plain as a man's hand.——A great many in our army digged pits in the ground before their lodging; many also were made to their hand, for it was a place where men wrought for

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* *History of the Sikhs*, p. 317.

† Alison's *Marlborough*, p. 272.

stone. To conclude—I never heard, in so short a time, such a number of cannon-shot; for we, on our side, meant to remove them thence by force of artillery, and they plied the matter diligently, and spared no powder."—*History of Philip de Comines*, book i. c. 9.

NOTE B.—BURMESE STOCKADES.

"At Wattygoon the position," says Snodgrass,[*] "had been chosen with their usual judgment by the Burmese engineers, having two sides protected by a deep morass. A jungle covered the approach on the third side; the rear alone was open ground, and the only part from which the works could have been advantageously assailed."

These works were of great size. At Melloone the principal stockade appeared to be a square of about a mile.[†]

The most remarkable of the Burmese intrenchments was the Stockade of Donoobew. It "extended for nearly a mile along the sloping bank of the Irawaddy, its breadth varying from 500 to 800 yards. The stockading was composed of solid teak beams from 15 to 17 feet high, driven firmly into the earth, and placed as close as possible to each other. Behind this wooden wall the old brick ramparts of the place rose to a considerable height, strengthening the front defences by means of cross-beams, and affording a firm and elevated footing to the defendants. Upwards of 150 guns and swivels were mounted on the works, and the garrison was protected from the shells of the besiegers by numerous well-contrived traverses and excavations. A ditch of considerable magnitude surrounded the defences, the passage of which was rendered still more difficult by spikes, nails, holes, and other contrivances. Beyond the ditch several rows of strong railings were next interposed, and in front of all an abattis, 30 yards broad, and otherwise of a most formidable description, extended round the place, except on the river side, where the deep and wide Irawaddy presented a sufficient barrier, its breadth not exceeding 700 yards; and not a boat could pass without being exposed to heavy fire from the stockade."[‡]

In the attack of a position, also, the Burmese excavated cover, which is thus described: "The trenches were found to be a succession of holes capable of containing two men each, and excavated so as to afford shelter both from the weather and the fire of the enemy; even a shell lighting in the trench could at most kill but two men.

"As it is not the Burmese system to relieve their troops in making these approaches, each hole contained a sufficient supply of rice, water, and even fuel, for its inmates; and under the excavated bank a bed of straw or brush-wood was prepared, in which one man could sleep whilst his comrade watched. When one line of trench is completed its occupiers, taking advantage of the night, push forward to where the second line is to be opened, their place being immediately taken up by fresh troops from the rear, and so on progressively—the number of trenches occupied varying according to the force of the besiegers, to the plans of the general, or to the nature of the ground."[§]

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[*] *History of the Burmese War*, chap. xx.

[†] *Ibid.*

[‡] Snodgrass, chap. xiv.

[§] Snodgrass, p. 103, 104.

During Bundoola's grand attack on the British position at Rangoon, in December 1824, his men by help of such excavations maintained themselves for several days at half musket-range from our lines, whilst exposed to every species of fire. They were only to be dislodged by means of the bayonet.*

NOTE C.—SHELLS FIRED WITHOUT MORTARS.

I remember hearing, some years ago, in India, that Lena Singh Majeetia, a Sikh chief, well known for his attachment to the curiosities of European science,† and for his cautious abstinence from committing himself against the British Government in the late Punjab troubles, had exhibited to some officers at Umballa an art, which he professed to have, of firing shells without ordnance of any kind. Unfortunately, I have no notes of the particulars; but, as the circumstance was related, the Sirdar, with one native assistant, concealed himself within a canvass screen, having no apparatus but a shell, a tent peg, and an ordinary digging-tool; and in due time the shell was discharged, ranging to a considerable distance. Some light is thrown on the subject by a passage which Daniel, in his *Histoire de la Milice Française*, (vol. i. p. 581,) extracts from Blondel's *Art de jetter les Bombes*. This describes how the Poles, in besieging Thorn in Prussia, when held by the Swedes in 1659, shot into the town vast pieces of rock and quarters of mill-stones without using mortars, by digging in the ground, near the counterscarp, holes adapted to the form of the stones, furnished with chambers at the bottom, and having their axes inclined at a suitable angle.‡

In 1771, a Mr Healy at Gibraltar cut a mortar in the rock, about 200 yards above the level of the sea, and 400 yards from the line wall. It was 3 feet in diameter, and 4 feet deep, with a parabolical chamber at the bottom, and the axis was directed at an elevation of 45°. Being loaded with 27 lb. of powder, covered with a tompion, and over this charge some 1500 lb. weight of stones, it was fired by a hollow reed and copper tube passing through the stones and tompion to the centre of the chamber. About a fourth part of the stones went into the sea about 100 yards beyond the wall. The mortar was fired three times without suffering the least damage.§

NOTE D.—SIR JOHN JONES.

Sir John T. Jones was born March 25th, 1783, and obtained his commission in the Royal Engineers in 1798. In 1805 he accompanied Sir James Craig's expedition on the rash landing at Naples, and subsequent retirement to Messina. Next year he was with Sir John Stuart's army in the brilliant Calabrian campaign, was present at Maida, (4th July,) and took part in the siege of the celebrated Rock of Scylla. In consequence of a suggestion of Captain Jones's having been followed out, by constructing a communication with the sea, a British garrison was enabled to maintain the castle till 1808, and, after the French had reduced it to ruins, to withdraw without losing a man in the operation.

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* MS. Note by Major Seton, Madras Artillery.

† Lena Singh was the constructor of the beautiful field-battery taken from his brother, Runjoor Singh, at Aliwal, and a part of which is now, it is believed, at Windsor Castle.

‡ They turned the Earth into a piece of ordnance. So have I seen, beside the hot springs of Jumnotri, the Himalyan mountaineer excavate a tiny hollow in the hill-side, fill it with the fragrant weed, and use all Earth for his Tobacco-pipe.

§ Grose's *Military Antiquities*, App., No. VII.

In 1808, Captain Jones (who had mastered the Spanish language when a subaltern at Gibraltar) was sent with General Leith as one of the Military Commissioners attached to the Spanish army. On Moore's retreat commencing, he, with his chief, joined the army, and was present at Corunna.

Captain Jones's next service was on the miserable Walcheren expedition, in which he acted as brigade-major of his corps at the attack on Flushing. In 1810 he returned to the Peninsula, and took charge of the celebrated Lisbon lines, then in progress. Lord Wellington always paid great attention to his suggestions. On joining headquarters, Captain Jones was made brigade-major to the corps, and was mentioned with distinguished honour by the Commander-in-chief for his services at the sieges of Ciudad Rodrigo and Badajos, for each of which he received a step of brevet rank. At Burgos, when in the act of making a signal to Lord Wellington, which he had to repeat again and again, he drew on himself the fire of a whole line of musketry, and fell, shot through the ankle-joint. His sufferings in travelling to Lisbon were most severe; for eighteen months he could not use his leg, and his health was never good afterwards.

In November 1814, by convention between England and the Netherlands, the Duke of Wellington was empowered to carry out the works necessary for the defence of the latter kingdom, and a sum of six and a half millions was assigned for the object. The Duke appointed Colonel Jones *sole* inspector, with full deputed powers, to carry out these works, which he achieved with the greatest satisfaction both to the Duke and the Dutch King. The duties of inspector he performed till the Belgian revolution in 1830.

In 1825 he had been appointed aide-de-camp to the King, and in 1831, on the recommendation of his old chief, he was made a baronet. In 1837 he became a general officer and K.C.B.

In October 1840, Sir John Jones, at the request of Government, though his health was much broken, proceeded to Gibraltar, where he drew up full reports on the state of that fortress, and estimates for remedying its defects. All his recommendations have been carried out. This was his last public service. He died at Cheltenham 25th February 1843.

The reputation of Sir John Jones is not confined to England; it has spread in the Continental armies—and, whilst in life, he was always received among them with honour. Undoubtedly he stands at the head of British military engineers, and in his day might rank among the first in Europe. With great personal experience, talent, and acquired knowledge, he was a man of sound and clear judgment, and of deep reflection. He was devotedly attached to his profession, and often said that he would rather serve at one siege than at six battles.

His principal work, the *Journals of Sieges in Spain*, which is a storehouse of military wisdom, was first published in 1813. It has since gone through several editions, and has been translated into French. Sir John Jones was the first author who published a history of the war in Spain, (1814,) since superseded by Napier's more elaborate work. He also printed (privately) an account of the Lines at Lisbon, which has been since published.—(Mainly from a biographical notice in the *United Service Magazine* for 1843.)

NOTE E.—FRANCESCO DI GIORGIO.

Francesco, the son of Giorgio, the son of Martino of Siena, was born in a humble rank of life about 1423. The earliest notice of his professional labours is in 1447, when he was employed as one of the architects of the cathedral at Orvieto in the Roman States—an edifice the restoration of which engaged the genius of a still more celebrated engineer and architect, Michael San Michele, in the next century. He was afterwards employed by Duke Frederic of Urbino, and continued in the same service till that prince's death. In 1478 he was attached to the allied army which the duke commanded, and in his autograph MSS. he speaks of having one hundred and thirty "edifices" on hand at once under his orders. Among these, doubtless, were many strongholds in the duchy.* Plans of four, at least, which he executed have been preserved. The duke not only kept this most able engineer of his time in constant employment, but, according to Francesco's testimony, by his own experience and judicious suggestions, greatly facilitated the tasks which he imposed. He was also accredited, on various occasions, as the duke's envoy to the government of his native city; and his book on architecture is dedicated to Duke Frederic, at whose request, probably, it was composed.

His military reputation was widely spread in his lifetime, and he had commissions from various princes, especially the sovereigns of Milan and Naples. He is stated also to have been employed as an engineer by Pope Pius II. The time of his death is not certainly known, though it is supposed to have occurred about 1506. He outlived most of his fortresses, which were dismantled by Duke Guidobaldo, the son of Frederic, when he abandoned his territory on the invasion of Cæsar Borgia in 1502.

Vasari says that he was particularly eminent in the construction of engines of war, and zealous in the study of military antiquities, as well as in that of the structure of ancient amphitheatres and similar edifices. He did more to facilitate the progress of architecture, says the same writer, and performed more essential services for that branch of art, than any other master had done from the time of Brunelleschi.

Francesco was a sculptor and a painter, as well as an architect and engineer. His paintings are excessively rare; but a few remain at Siena, his native place. As a sculptor, he produced two angels in bronze, which were placed on the high altar of the cathedral in the same city; and he engraved a medal of his patron, Duke Frederic, as well as painted his portrait.

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* "The fortresses of Urbino at that period have been estimated at nearly three hundred, a number which must seem incredible, but for the entire change which the arts of war and defence were then undergoing, consequent on a general introduction of artillery."—Dennistoun's *Dukes of Urbino*, ii. 203.

These scanty notices are derived from Mr Dennistoun's *Memoirs of the Dukes of Urbino*, and from Vasari's *Lives*. A better account of him might have been given, had I been able to procure a copy of his *Treatise on Civil and Military Architecture*, supposed to have been written about 1480, which, after it had lain in MS. for more than three hundred and fifty years, was published at Turin in 1841, with a sketch of the author's life, and dissertations on the state of military architecture in Italy during the fifteenth century.

The brief indication of the style of his projects which is given in the text of the present work, has been derived from an interesting notice of the military portion of Francesco's Treatise, contributed to the *Royal Engineer Corps Papers* by Capt. Tylden, R. E.*

Treating of the defence of ditches, Francesco says, "These simple ditches can be defended in various ways, *of some of which, not to burden my conscience, I shall make no mention,* because, without doubt, they can be arranged with little difficulty in such manner that a great number of men may be destroyed unawares at once." †

This may possibly allude to counter-mines, or fougasses, charged with gunpowder. Capt. Tylden does not notice any other reference (supposing this is one) to the subject; but this is probably an accidental omission, as there seems to be no doubt that Francesco di Giorgio was acquainted, at least theoretically, with the use of gunpowder in mining, and wrote on its application. Gibbon alludes to his having left MSS. on the subject,‡ quoting Tiraboschi; and the relation in Mézéray's French history, that the mines at the Castel del Ovo, in 1503, were directed, not by Peter Navarre, but by one Francis George, an architect of Naples, undoubtedly is a confused reference to this fact. Mr Dennistoun says that Francesco wrote on the use of "explosive mines for the destruction of military defences. *Such an application of gunpowder had already been partially resorted to,* but the Sienese engineer first established its importance, and methodised its application." I do not know to what the italicised words refer, as the first application is believed to have been in 1487, whilst Francesco's MSS. are understood to date previous to 1482.

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* Vol. i. p. 170 of the octavo papers, (1849.)

† Scruples of conscience similar to Francesco's were entertained by the great Napier concerning a "long range" which he invented, according to the eccentric Sir Thomas Urquhart. "As for Neper, (otherwise designed Lord Marchiston,) . . . he had the skill (as is commonly reported) to frame an engine which, by vertue of some secret springs, inward resorts, with other implements and materials fit for the purpose, inclosed within the bowels thereof, had the power to clear a field, of four miles' circumference, of all the living creatures exceeding a foot of height that should be found thereon. . . . When he was most earnestly desired by an old acquaintance, he would be pleased, for the honour of his family, and his own everlasting memory to posterity, to reveal unto him the manner of the contrivance of so ingenious a mystery, ... his answer was, 'That for the ruine and overthrow of man there were too many devices already framed, which if he could make the fewer, he would with all his might endeavour to do; and that therefore, seeing the malice and rancor rooted in the heart of mankind will not suffer them to diminish, by any new conceit of his the number of them should never be increased.' Divinely spoken, truly!"—*The Jewel*, &c.

‡ *Decline and Fall*, ch. lxviii., note.

NOTE F.—ALBERT DURER'S FORTIFICATION.

The work of Albert Durer was originally published at Nuremberg in 1527, under the title of *Unterricht von Befestigung der Stätte Schloss und Flecken*, (Instructions for the Fortification of Cities, Citadels, and smaller Fortresses;) and a Latin translation was published at Paris in 1535. The latter is the only edition I have seen.

He begins by remarking on the inefficiency of the ancient town-walls to stand against the developed power of modern artillery; and points out that no fortress intended to resist heavy guns should have lofty exposed surfaces of masonry; for, however thick this may be made, continued cannonade will destroy it, and the greater the mass the heavier will be its downfall. It is not his purpose to speak of (what we call field-fortification) those palisaded structures of turf which the occasions of campaigning give rise to, because the principles of such works are simple: they are generally understood by men who have seen service; and as soon as the danger ceases these intrenchments are allowed to go to decay.

"Should the expense of his projects be objected to, let it be remembered how the Egyptian kings lavished far larger sums on monuments which served no useful end. And besides the security from external and internal foes which States derive from fortresses, how great an object does their construction subserve in providing employment for the idle poor, and in so relieving the commonwealth of beggars and seditious persons."

In his project for fortifying a city, the ditch is made 300 feet broad and 50 feet deep, with a cunette adjoining the escarp of 18 feet broad and 12 deep, that the enemy may not surprise the place by the casemate embrasures. At each salient of the city-wall he then establishes great semicircular bulwarks—or castles rather—having a diameter of 300 feet, and cut off square at the gorge, which is enclosed. The interior is divided into sectoral spaces by long counterforts or radiating piers, and the whole roofed with timber,* the command of the terrace, or roof, being very little above the surrounding country, so that the mass of masonry is shielded from distant fire. There are but two tiers of guns, one on the terrace, the other in casemate just above the level of the main ditch. The embrasures are 20 feet apart, and splaying inwards and outwards from the neck, which is only 3 feet from the outside, so that the muzzle of the gun may project beyond the masonry. The town-wall, where it joins the bulwarks, is lowered so as to allow the play of the guns on their flanks.

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* This would be sufficient to show that the use of shells did not require to be provided against in Durer's time. Still, vertical fire was practised; but it consisted of stone shot discharged from the huge pieces called *Bombards*, and the operation was so slow that perhaps no extensive damage was to be apprehended from them. Thus the great Basilisk of Mahommed II., at the siege of Constantinople, in 1453, like the monster mortar of the French in 1832, could only be fired some seven times a-day.—(Gibbon, lxviii.) Shells are described by Maggi as a novelty in 1563; but according to Stowe, (*Penny Cyc.*, art. Artillery,) they had been cast for King Henry VIII. twenty years before, by one Peter Bawd, a Frenchman. A mortar throwing a shell (or at least a ball from which fire issues) is very plainly represented in the woodcut frontispiece of Tartaglia's *Nova Scientia*, first published in 1537.

At Auberoche (1344) the vertical discharge of stones from engines was so heavy that the garrison were confined to vaulted rooms on the ground-floor.—Froissart, i. 106.

The bulwarks, being closed and armed at the gorge, form each an independent *Réduit*, which may be maintained in the event of the town being carried by the enemy, or rising in insurrection. No outworks are described.

The mouths of the embrasures may be covered with timber shutters a palm thick. These shutters are composed of long spars balanced see-saw fashion on a trestle over the gun, and having a trifling preponderance to the front. Thus, at rest, the fore ends dip to meet the sill of the embrasure, while the slightest touch behind is sufficient to cant them up, so as to allow of the piece being discharged, on which the shutter is immediately let fall again. This is a very ingenious suggestion, and seems admirably practical from the facility with which it is constructed and worked, the promptitude with which a shattered beam could be replaced, and the tendency which the slanting position of the shutters would have to reflect a bullet. A double row of ventilators is provided in the casemate for the escape of smoke.

Various designs of similar bulwarks are given to suit different circumstances; and the remainder of the work contains detailed projects for square and circular fortresses and castles, with double and triple enceintes, ditches flanked by rectangular caponières, &c. But what has been said will give an idea of the prominent feature of Albert Durer's book.

In some of his elevations, the upper part of the escarp, for about a third of its height, slopes back at an angle of about 45°; with the view of reflecting shot upwards, and rendering escalade difficult. It appears very efficient for the latter purpose, and is adopted in Castriotto's work. A similar construction, I suppose with the same view of hindering the use of ladders, has been adopted for the *counterscarp* of the works lately constructed across the isthmus at Aden.

A precept of Durer's marks how far some municipal powers of our day lag behind the wisdom of Nuremberg in the sixteenth century. In his project for a city he provides a cemetery without the walls, and prohibits all intramural interment as destructive to health.

We see that he has anticipated the *rasant* profile of the French school of the last century; and his great bulwarks, or castle-redoubts, appear to be the originals of some of Montalembert's characteristic projects. They are very strongly recalled to mind by the rounded keeps of the new German fortresses on the Rhine; and still more especially by the manner in which these are applied to a continued enceinte in the *tête-de-pont* at Ingoldstadt, and, on a small scale, in the Prussian works on the Cyriacsberg at Erfurt.*

Note G.—San Michele.

Michele San Michele was born at Verona in 1484, of a family which had produced many architects. Having acquired the elements of his art under his father Giovanni and his uncle Bartolomeo, at the age of sixteen he went to Rome to complete his studies. To these he applied with such diligence and capacity that he soon acquired reputation, and was extensively employed in the towns of the Roman States. He was commissioned by Pope Clement VII., in company with the architect San Gallo, to inspect and restore the fortresses of the papacy, especially Parma and Piacenza, as being the most remote from Rome, and most exposed to the perils of war. Having completed this duty, Michael proceeded to visit his family at Verona, and to extend his knowledge of military architecture by examining the Venetian fortresses. This led to his being apprehended and imprisoned as a spy. After examination, however, he was not only set free, but service on liberal terms was offered him by the Venetian State. This offer he soon after took advantage of, and his first task was the construction of a grand bastion on the defences of his native city, in which he gave great satisfaction to the Signory and their captain-general the Duke of Urbino. He was then commissioned to submit a model for the defences of Legnago on the Adige, and the fortress covering the bridge-head at that place. This also having executed in a masterly manner, he continued with growing reputation to report on all the places of the Venetian territory, designing necessary improvements, and reconstructing several from the foundation. He was then despatched on an extensive commission of the same kind to the foreign possessions of the republic—proceeding first to Dalmatia, where he left his nephew Gian Girolamo, himself an eminent engineer, to carry out his designs, and thence to the islands of Corfu, Crete, and Cyprus, in all which he executed important works, especially the fortifications of the cities of Candia and Canea, in Crete, which he reconstructed with extraordinary strength, and so, probably, preserved the island to Venice for upwards of a century. He also appears to have acted as engineer in Napoli-di-Romania, when successfully defended against the Turks.

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* See *R. E. Prof. Papers*, vol. ii., Plates 14 and 16.

On his return from his Levantine labours, a great work was committed to him—the fortification of the Lido, at the mouth of the port of Venice. It was an engineering operation of great difficulty, the site being a marsh, surrounded on three sides by the sea. The foundations were laid on piles enclosed in a double cofferdam, from which the water was extracted. On these San Michele reared "a terrible and marvellous fortress, the rusticated masonry of its outer walls being composed of blocks of Istrian stone of vast size; so that the edifice, whether for the difficulties overcome in its construction, or for the splendour of its execution, was one of the most stupendous in Europe, and a worthy match for the most famous works of Roman greatness." * Some envious persons maintaining that the structure would never bear the discharge of the vast artillery required for its armament, the Signory caused the whole of its double tiers of embrasures to be armed with the heaviest ordnance in the arsenal, and a salvo to be fired from all at once. So tremendous was the roar of the artillery, and the earthquake occasioned thereby, that it seemed like the crack of doom. But not the slightest failure occurred in the structure.

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* Vasari.

San Michele and his nephew were several times invited, with high offers, to transfer their abilities to the service of the Emperor Charles and of Francis I.; but they declined leaving their natural lords to serve strangers, and both continued in the employment of the Venetian State for the remainder of their lives.

Michael, by many of his most elaborate works, augmented the strength and beauty of his native city. Among his works there were, a noble bridge across the Adige, three magnificent gateways, and several bastions after the modern fashion, which, according to Vasari, he invented—substituting angular faces for the circular bulwarks, and open flanks for the ancient casemates.

The list of his constructions and designs is enormous—embracing churches and convents, palaces, bell-towers, and sepulchres, besides his yearly labours in the repair and improvement of military structures. And all his works were done so thoroughly that, for years after, not a crack was to be seen in them.

San Michele was a courteous and liberal gentleman, devout after the manner of his country. He stood high in the favour of princes and pontiffs, and was much esteemed by Michael Angelo, and other illustrious contemporaries. His old age was afflicted by the death of his nephew, and colleague as engineer to the republic, Gian Girolamo, and he did not long survive. Michael died in 1559, at the age of seventy-five.*

A critical character of San Michele's architectural designs will be found in the *Penny Cyclopædia.*

NOTE I.—EARLY INDICATIONS OF A BASTION TRACE.

We may conceive a double origin of the trace as probable. The bastion with angular shoulders may have been the natural result of the square tower applied to an angle of the city wall, (See Pl. VIII., fig. 116,) whilst the bastion with round orillons, in its original ace-of-spade shape, seems an easy deduction from the long-necked roundels of Francesco di Giorgio.—(See Pl. V., figs. 84 and 85.)

In looking at the trace of the walls of Mycenæ, (Pl. V., fig. 86,) the date of which is referred to the dim Pelasgian times, and comparing it with the outline of the Torres Vedras field-fort, (Pl. V., fig. 73,) surely, without any antiquarian clairvoyance, one may see in the former the indication of bastions and a bastioned front. This may have been a mere accident, arising from the contour of the hill on which the fortress stands. But it is remarkable how the whirligig of changes moves, if not in a circle, at least in a spiral, expatiating in a wider field of science, but still returning opposite the point which it had passed many centuries ago. So we see here the bastions of the sixteenth century anticipated in the rude Cyclopean walls of Mycenæ abandoned for more than 2200 years; our modern speculators in fortification, Carnot and Ferguson,† reverting, in the concentric circles of their ramparts, to the round raths and hill-forts of our remote predecessors in the British isles, or to the form which Herodotus ascribes to the sevenfold *enceinte* of Ecbatana; our Browns and Telfords, in their suspension-bridges, perfecting with all the appliances of modern art the rude swings of grass-rope or rattan, which for unknown ages have spanned the mountain rivers of north-eastern India; and, last of all, Stephenson and Fairbairn, carrying our thoughts back to the world's youth, when a pine falling over a stream gave man his first bridge, direct all the plenitude of English gold and iron, all the resources of calculation, experiment, and practised skill, to span the Menai with *a single beam.*

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* Abridged from Vasari—*Vite de Piu eccellenti Pittori, Scultori et Architetti.*

† The former in his *Fortification Primitive*, the latter in his *New System of Fortification*, (1849.)

NOTE J.—TARTAGLIA.

Nicholas, surnamed Tartaglia, (the Stutterer,) a celebrated mathematician and speculative philosopher, was born at Brescia about 1500. He has told us his early history, and how he got his nickname, in one of the dialogues contained in his book called *Diverse Questions and Discoveries.* His father filled the humble office of letter-carrier to their honours the magistrates of Brescia, and was generally known as "Little Mike the Postboy," (Micheletto Cavallaro.) If he was entitled to any other name his son was not acquainted with it, the father having died when the latter was six years old, leaving his family in poverty. When the French sacked Brescia in 1512,* their house was plundered of what little it held, whilst the widow, with her children, took refuge in the cathedral. This did not save them from the violence of the troopers, and little Nicholas got five severe wounds in the head and face, one of which broke his jaws and disfigured him for life. It was long before he could speak plainly again, and hence he acquired from his playmates the soubriquet which he afterwards adopted as a surname. Before his father's death, the child had a few months' schooling; and, when fourteen years old, he went of his own accord to a writing-master. The fees being payable by instalments according to progress, when Michael had achieved the A, B, C, as far as K, his funds were expended, and he could pay for no further tuition. "After that," he says, "I had never another master, but ever worked in company with that daughter of Poverty whose name is INDUSTRIA."

In that good company Tartaglia studied to such good purpose as to reach the highest rank among the mathematicians of his time. After teaching at Verona and Vicenza, he became professor of mathematics in his native city, and afterwards at Venice, where he died in 1557. His fame mainly rests on his discoveries in algebra. In the solution of cubic equations he was the real inventor of the method known as Cardan's rule. It was communicated to the latter under a solemn promise of secresy, but published by him in a work of his own notwithstanding.

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* Under Gaston de Foix. "And as the miseries that war draweth with it are infinite, so the whole citie for vii dayes together was exposed to the covetousnesse, to the lust, and to the crueltie of souldiers; things sacred as well as prophane being parcel of the praie: and no lesse the lives than the goods of men committed to the discretion of spoylers."—Fenton's *Guicciardini*, book x.

The Essay on Fortification forms one of the books of the collection of questions above mentioned, and consists of two series of dialogues. In the first, held with His Reverence Gabriel Tadino, Knight of Rhodes and Prior of Barletta, the latter questions Tartaglia as to the possibility of the art of fortifying reaching a higher pitch of perfection than it had then attained, as exemplified in the defences of Turin. Of these he exhibits a plan, showing the place as a square bastioned fort, with cavaliers in the middle of the curtains.

Tartaglia gives the knight to understand that he sees very little merit in this trace, and that it is deficient in six properties which he considers essential to good fortification. These are: 1st, That the curtains should be so traced that they can only be battered obliquely. 2d, The contour should be such that any possible site of an enemy's battery must always be nearer to some one of the bastions than to the curtain which it is intended to breach. 3d, That an assailant at any point should be exposed to an artillery fire from at least four distinct works. 4th, That the curtain should be so constructed that, if breached, in ruins it will be a greater obstacle to the enemy than before. 5th, That the place should be secured by some contrivance for enabling a very moderate guard on the curtain to baffle any attempt at escalade with heavy loss and disgrace to the assailants. 6th, That to supply the garrison with food there should be such an arrangement of works as shall allow of ground being cultivated under the guns of the place, and protected from annoyance by the enemy. The series concludes with pledges on Nicholas's part to produce plans and models showing how all these desirable objects can be attained.

In the second set of dialogues, Dr Marc Antonio Morosini expresses natural curiosity to learn how the conditions are to be fulfilled. Tartaglia proceeds to explain one of his projects meeting the first three conditions—the poorest of all his designs, he says, since he would follow the shopkeepers' practice in showing his worst wares first. The trace is *en tenaille*, having bastions at both salient and re-entering angles, with cavaliers in the middle of the curtains; and on each side of the inner bastions along the curtains are thrown up a number of small oblique traverses, each armed with a falconet bearing on the space between the salients. There is a covered-way, wide enough for two carriages to pass each other, and a glacis with its crest only two feet lower than the curtain. He enlarges on the covered-way as a novelty. Though not found in Albert Durer, it is in Francesco di Giorgio's designs. Signor Morosini commends the plan as ingenious but odd-looking. "Illustrious sir," replies Tartaglia, "had Nature from the beginning made men without nose or ears, till by chance one was turned out in the possession of both, assuredly he would be considered by the rest as a very odd fellow. And so with my system. But be it as you will; in fortification we want strength, not symmetry."

The fulfilment of the paradoxical 4th condition is to be sought for in breaking the height of the escarp into two by a sort of berm wide enough to receive the ruins of the upper half of the wall when it is breached,* which he considers will render ascent more difficult instead of facilitating it; whilst the loose stones struck by the shot from the flanks will fly about, dealing destruction among the assailants. How No. 6 is to be accomplished is not explained, and there appears nothing else in the tract worth mentioning.

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* The escarps of Fort-William, at Calcutta, are constructed somewhat after this fashion.

Tartaglia does not appear to have professed fortification as an engineer, but merely to have taken up the subject speculatively, as he did many others. Many of the articles in his *Quesiti* are devoted to the theory of gunnery, though, as he says, he had never fired gun, bombard, musket, or arquebus; others are on the composition of gunpowder, on tactics, on surveying, and on mixed mathematical subjects. He also published the first Italian translation of Euclid, and many other mathematical works.

One of his books treats of the method of raising sunken ships, and in it he gives one of the earliest descriptions of a diving-bell. He does not appear to provide any means for replenishing the bell with fresh air.

NOTE K.—MARCHI.

Francesco de' Marchi, one of the most eminent Italian engineers of the sixteenth century, was born of a noble family at Bologna. He served Alexander de' Medici, first Duke of Florence, his widow Margaret, Duchess of Parma, and Pope Paul III. successively. In 1547 he constructed the fortress of Placentia, and for two-and-thirty years afterwards appears to have acted as engineer to the King of Spain in the Low Countries.

His work on fortification first appeared in 1546, but was published after his death in a more complete form at Brescia, in 1599.* It is entitled, *Della Architettura Militare libri tre, nelli quali si descrivono li veri modi del fortificare che si usa a tempi moderni.*" The work contains one hundred and sixty-one systems of fortification which Marchi declares to be of his own invention, and in which are to be found traces of most of the methods designed or executed by the ablest succeeding engineers. The work is now excessively rare and expensive. A copy containing some additional plates is stated to have been sold for about £55. The Italians allege that foreign engineers destroyed the copies of Marchi's work to conceal their own plagiarisms, including in this charge even Vauban, whose three systems, it has been pretended, were borrowed from Marchi.

The work was republished magnificently by Luigi Marini, at Rome, in 1810, in five folio volumes, which cost £20 to the subscribers.—(*Biographie Universelle.*)

Several of Marchi's systems are given in the *Travaux de Mars*, by A. Manesson Mallet. Amsterdam, 1684.

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* 1597, according to Colonel Portlock's list of Italian military writers in the *R. E. Corps Papers*, i. 65.

NOTE L.—MAGGI AND CASTRIOTTO.

Girolamo (or Jerome) Maggi was born at Anghiari, in Tuscany, in the sixteenth century. He was by profession a student of law, but devoted his leisure to military architecture and antiquities. Having settled at Venice, after holding various political and judicial posts in different parts of Italy, he was appointed by the Venetian government Judge of the island of Cyprus, and so was present in Famagosta (1571) when it was besieged by the army of Selim II. Maggi lent all his abilities and energy to the defence; and by his skill in the management of artillery and mines, as well as by the engines which he devised, greatly contributed to retard the capture of the city.

The Turkish trenches, hewn in some places through the rock, were carried on by 40,000 pioneers; their huge cavalier batteries mounted 80 pieces of artillery; and the army was so numerous that their leader boasted that, were each of his men to cast a slipper into the ditch, it would suffice to form a causeway to the rampart.

> "Such forces met not, nor so wide a camp,
> When Agrican, with all his northern powers,
> Besieged Albracca."

The garrison consisted of 7000 men, half Italians, half Greeks.

After a siege of four months, but not till after the magazines were empty and the ramparts a continuous mass of ruins, the gallant commandant, Marc Antonio Bragadino, consented to surrender. Most honourable terms were granted; but these were violated with ferocious treachery by the Turkish general Mustapha Pasha. Bragadino was mutilated and horribly tortured to death. Maggi, a prisoner with the rest, was sold to a shipmaster who took him to Constantinople. Whilst languishing in captivity there, from the resources of his powerful and well-stored memory alone, he composed two Latin treatises abounding in curious learning: one, *De Tintinnabulis*, suggested by the prohibition of bells in Turkey; the other, *De Equuleo*, (on the Wooden Horse,) by the instruments of torture in daily exercise before his eyes. He dedicated these to the ambassadors of France and the Empire, then at Constantinople, and they endeavoured to negotiate his deliverance. But in the meantime Maggi, in an attempt to escape, was recaptured; and by order of the Vizier was strangled in prison, May 1572. He left works, published and unpublished, on a vast variety of subjects. His treatise on fortification was printed at Venice as a commentary on that of Castriotto in 1564, and again in 1583–4. In it he frequently refers to a work of his own on "Ingegni Militari;" but this does not appear to have been printed.—(*Sketches of Venetian History—Biographie Universelle.*)

Of Captain Jacomo Fusto Castriotto I can find no particulars, save what are afforded by incidental allusions in his book. From these it appears that he was a native of Urbino, and that he was an engineer in the service of Pope Julius III., by whom he was employed in 1548 on the fortification of the Borgo at Rome, in 1552 to design the works of attack on the strong fortress of Mirandola, (though his *cattivo sorte* did not allow of his being present to execute them,) and to fortify Sermoneta, Palliano, Anagni, and other places in the Papal territory. Afterwards he attached himself to Henry II. of France, and was in the army of the Constable Montmorenci when he was defeated and taken by the Spaniards at St Quentin,—was present at the capture of Calais, (1558,) and at the sieges of *Don Carico* and *Borgo* in Flanders, (which I presume to represent Dunkirk and Bergues,) under the Maréchal de Termes, as well as at the ensuing defeat and capture of this general by the Spanish King. The last service which he mentions himself to have been present at was the capture of Thionville in Burgundy. He states that he had held various conversations with the great soldiers of the time—the Constable Montmorenci, the Duke de Guise, and the Admiral Chatillon (Coligny)—on the defects of existing fortresses, and had been employed to design new works in all parts of France.

The work called *Della Fortificatione delle Città*, (on the Fortification of Cities,) consisting of Castriotto's Memoranda, and designs, with comments by Maggi, is very sensible, and free from the geometrical pedantry of many of the old engineers. That there is nothing new under the sun is, in no branch of art, more true than in Fortification. There are probably few remarks or projects in modern essays on this subject of which an indication is not to be found in those of the sixteenth century.

The following are a few points selected from the book. The various features of a Fortress, besides the curtain, are the *Bastions or Bulwarks*, (Balluardi) ; the *Platforms*, which are small intermediate works either square or bastion shaped, in the middle of the curtain ; the cavaliers, generally over the platform, sometimes in the bastion or on the flank produced inwards ; the ditch ; the casemates, in the flanks ; the covert way (*via coperta, via delle sortite*) ; and the glacis (*spalto* or *argine.*)

The length of a front is laid down at about 400 yards, of the face of the bastion 73 yards, of the flanks 37. In Vauban's first system, with the same exterior side, the two last dimensions would be 114 and 60.

The square is not approved of on account of the acuteness of its angles. The salients of bastions should always be right angles or more.

In laying out a work always mark out the interior area first, otherwise your eye will probably deceive you, and your outline will be much too contracted.

In designing new fortifications be not contented with accurate plans; always make a model also.

It is recommended to plant poplar trees along the ramparts. This binds the soil well, and the trunks are most useful for retrenchments, &c.

Embrasures appear always to have been made narrow towards the middle, and widening both inwards and outwards.

Various patterns are given of escarp revetments, all well backed with counterforts. In one, Castriotto anticipates great benefit from throwing several tiers of brick arches between the counterforts. The latter always rise to the superior surface of the parapet. One of his designs on which he strongly insists is an anticipation of Cormontaingne's demi-revetment, a narrow berm intervening between the cordon and the parapet.

Against mining, Maggi recommends a cunette filled with water in the middle of the ditch. It is a good plan, he remarks, to make the bottom of the ditch not level, but forming an acute angle, so that the enemy entering it, are forced to crowd one on another, and cannot get a footing for their ladders. They are also exposed to artificial fire and shells, (then a novelty, and not in general use for 50 years after,) of which he gives a very clear description.

In one design of Castriotto's for a "gagliardo balluardo," or *jolly strong bastion,* we have the triple flank of the Count de Pagan very distinctly. Another design, for a star-shaped fortress with a polygonal interior retrenchment, has a strong general resemblance to some of Montalembert's outlines.

A project of Maggi's for retrenching a bastion is ingenious. The casemated flanks of the bastion are connected by a vaulted passage resting on masonry piers. These piers are mined, and when the enemy masters the bastion the mines are sprung. This throws off the roof of the passage, converting it into a deep ditch with masonry scarps, isolating the bastion.

In Book iii. Chap. 20, both authors give brief and good instructions for the benefit of a governor expecting his place to be attacked. Provision of sufficient aid in doctors and medicines is mentioned.

Several detached memoirs are included in the 3d Book. One is a discourse on field intrenchments by Maggi, in which he alludes to, and appears to appreciate, intrenched camps attached to fortified cities, giving as an example a drawing by Castriotto of one executed in Picardy in 1557, under the walls of Compiègne. Some recommend, he says, when a prince is in personal command, that an inner work should be constructed surrounding his pavilion. But this he objects to as implying distrust of the general intrenchments of the camp, and so disheartening the troops. He suggests that portable intrenchments might be carried about, consisting of mattresses stuffed with wool or sea-weed, covered with leather cases. Besides, quoth he, when they are not wanted for fieldworks they would serve to sleep upon ! "I would not here omit to mention that, when the enemy is advancing to attack you before you have finished the intrenchment of your position, and begins to disturb your work with his artillery, it is a good plan to have webs of canvass or other stuff, such as are used in driving boars and other large game to the nets, which you may spread in front as screens, so that the pioneers who are at work shall not be exposed to the aim of the enemy's bombardiers ; and from not seeing, as well as from not being seen, they will work both with more spirit and with greater security." An admirable suggestion, which has been too rarely acted on.*

Then follows a Report by Captain Francesco Montemellino of Perugia, on the Fortification of the Borgo at Rome, which very clearly and intelligently discusses the *pro* and *con* of high and low sites for fortifications.

Next comes a treatise on various orders of battle by Captain Giovachino da Coniano, as practised by him when sergeant-major (*i.e.* adjutant-general) of the Italian infantry in the service of King Henry VIII. in his last campaign against Francis the First, in the neighbourhood of Boulogne—the Conte di Sore (Surrey) being general of the army. It is amusing to observe his mention of the corps of Irish *Salvatici*—savages, just as we should speak of Red Indian allies in an American campaign.

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* See *ante*, p. 123. A similar device is mentioned in Albert Durer's book.

The book concludes with Castriotto's memoir on the defects of existing fortresses. His principal remedies are the demi-revetment (compelling the enemy to crown the counterscarp before they can open breaching batteries), and the more general employment of wet ditches.

The illustrations, which are numerous, are very rude woodcuts.

NOTE M.—THE CHEVALIER DE VILLE.

Antony De Ville, an engineer of high reputation in his day, was born at Toulouse in 1596, of an honourable Dauphinese family. After acting for some years as engineer to the Duke of Savoy, who acknowledged his merits by bestowing on him the orders of St Maurice and St Lazarus, he returned to his native country, and served with distinction on the Belgian frontier, in the war with Spain, from 1636 to 1639. On the conclusion of peace he was employed in fortifying the towns ceded to France by the treaty. He died in 1656 or 1657, having attained the rank of Maréchal-de-camp.

His principal work, *Les Fortifications du Chevalier A. de Ville*, was first published at Lyons in 1628, and several times reprinted in the next forty years. It is illustrated with plates engraved by himself. He also published a treatise on the duties of Governors of Fortresses, (folio, 1639,) and narratives of the sieges of Corbeye (1637,) Landrecies (1637,) and Hesdin (1639,)* containing many judicious observations, besides illustrating in an interesting manner the practice of sieges at that time.—(*Biographie Universelle ;* Allent, *Hist. du Corps du Génie.*)

The works of Antony Deville are very highly spoken of by Carnot, and he quotes them copiously in his Essay on the Defence of Fortresses.

NOTE N.—THE COUNT DE PAGAN.

Blaise François, Count de Pagan, descended of a noble Neapolitan family settled in Provence, was born in 1604, entered on his military career at twelve years of age, and before he was twenty had been present at many, and had directed some sieges. Before Montauban, in 1621, he lost his left eye by a musket-shot. In every action he was distinguished by some feat of courage or address, and Louis XIII cited him as one of the most gallant and accomplished gentlemen of his kingdom. In 1642 having been sent to Portugal, his remaining eye was there destroyed by disease. Retiring with the rank of Maréchal-de-camp, (then next to that of Marshal of France,) he devoted the rest of his life to mathematical studies, and published several works on astronomy of considerable merit, though tinged with astrological views. One of his books (1655) was a translation of an account of the Amazons

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* See an outline of Deville's attack on this occasion, in Plate VII., fig. 102.

River, written by a Spanish Jesuit. To this a chart of the river and country was appended, which De Pagan is said himself to have compiled from the data, blind as he was. His house was the rendezvous of the most intelligent society of Paris till his death there, in 1655.—(See an account of him in Perrault's *Hommes Illustres du dernier Siècle*, of which this is an abstract.)

Note O.—Vauban.

Sebastian Leprestre de Vauban was born in Burgundy, May 1st, 1633, of a noble but impoverished family, eleven of whose members died on the field in the service of their country.

At seventeen he began his military life in Condé's regiment, then in the service of Spain—a circumstance little surprising in the bewildering embroilments of that period, when the most illustrious generals of the nation are found fighting now for France, and now for her enemies. He had already been employed as an engineer before he was twenty years old, at which age he was captured by the Royalists, and induced by Mazarin to enter the King's service.

He speedily rose to his acknowledged position as the first of French engineers; and his military life would embrace a chronicle of all the sieges in the wars on the Flemish frontier—with Spain first, and then with Holland—which filled the last half of the seventeenth century. All the most notable of these sieges he directed in person, but it so chanced that he never was called on to act in the defence of a besieged place.

After fifty years of unflagging exertion for the benefit of his country he received the Marshal's baton (1703,) not then for the first time offered, and died March 30th, 1707, full of years and honour, leaving behind him one of the most spotless names in military history, as "the first of engineers and best of citizens,"—a noble example in the devoted servant of an absolute monarch, of a patriot in the best sense of the word. Besides carrying the arts of defence and attack to a degree of perfection unknown before, he was eminently a humane and honest man, at once loyal and independent, clear-souled, and guided in the right course as by a natural instinct; in war prodigal of no man's blood but his own. He was often wounded, and a shot in the cheek which he received at Douay in 1667 marked him to his dying day, and is indicated in his portraits. Voltaire says that he was "ignorant," referring, I suppose, to scholarship, for in no usual sense could Vauban be called an ignorant man. His exterior was that of a bluff soldier; but his simple and kindly manners agreed with the modest, truthful, and genial character of the man. When Louis XIV., at Cambrai (1677,) threatened a violation of one of the humaner laws of war, Vauban alone fearlessly raised his voice in dissuasion; and not once only, but again and again, did this noble soldier in writing remonstrate with the King on his treatment of the Protestants, and his revocation of the Edict of Nantes.

In peace Vauban was as laborious as in war, and left behind him a vast mass of MSS., embracing projects for internal navigation, for the improvement of ports, for the defence of the frontiers, and the fortification of the capital, (accomplished in our day); essays on tactics, finance, commerce, the relation between church and state, geography, mathematics, and many other practical subjects, besides those immediately connected with his own professional duties.

He is said to have been present at one hundred and forty actions, to have conducted fifty-three sieges, to have repaired or improved some three hundred fortresses and ports, besides constructing thirty-three new ones. But, as is well said by the historian of the corps of which Vauban was so long the glory and the patriarch, "Such services as his are to be weighed, not numbered." *

NOTE P.—THE TENAILLE.

Though the introduction of the work now so called is due to Vauban, an outwork bearing the same name was in use before his time. In Cromwell's account of his attack on Drogheda, he says, "There was a *Tenalia* to flanker the south wall of the town, between Duleek gate and the corner tower, which our men entered; wherein they found some 40 or 50 men of the enemy, which they put to the sword." † In a plan of the attack of Bois-le-Duc by Frederic Henry, Prince of Orange, in 1629, a work is represented under the name of the Tenaille. It is like a hornwork, but having on the front two complete bastions, instead of demi-bastions, and the long side branches expanding towards the gorge, so that the whole outline is really like a *Tenaille*, or pair of tongs.

A hornwork of somewhat similar shape, at Tortosa, as besieged by Suchet in 1810, is termed the fort "*de las Tenaxas*,"—of the tongs.‡

In some old books of Fortification the name of Tenaille is given to a large advanced work, covering the whole of the ravelin, and having its front broken into a simple re-entering angle.

Coehorn, in speaking of Vauban's Tenaille, does not give it that name at all. "Les Français ont très joliment inventé un ouvrage devant la courtine, qu'ils appellent une *Fausse-braye*, que nous appellerons Basse-courtine." §

It is curious that an outwork exactly corresponding to Vauban's Tenaille, (except that it is straight,) is described and drawn by Castriotto,|| as he had seen it in the English fortifications at Calais, when that town was taken by Henry II. of France in 1558. A somewhat similar work is the only feature of any mark to be found in a large folio on fortifications, by Galasso Alghisi, Venice, 1570.¶ It appears hopeless for any engineer to vindicate his claim to the invention of a novelty in fortification: let us go back as far as we can find books on the subject, we seem fated to encounter the elements of every feature in modern engineering, and an anticipation of each improvement, which is

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* Allent, *Histoire du Corps du Génie*, Paris 1805, which contains a detailed history of Vauban's services, and (in Appendix) a list of his writings.

† Carlyle's *Cromwell*.

‡ Atlas to Suchet's *Memoirs*.

§ Coehorn's *New Fortification*—French trans., 1706.

|| *Fort. delle Città*, book ii. chap. 24.

¶ The curtain forms a deep re-entering angle; and this work, called *Isola*, is of a delta form, occupying the space.

supposed to be invented in our day. Captain Nelson, writing in the *R.E. Professional Papers* * aptly compares the projects of system inventors to the variations of the Kaleidoscope, changing in pattern, but still only permutations of the same few pieces. And he illustrates his own remarks by himself bringing forward a project for discussion, the main feature of which appears to be a revival of the "reinforced" or indented curtains of Marchi and Castriotto. In the *Corps Papers*, vol. i. p. 418, another officer, writing on improvements in sapping, suggests the substitution of rectangular coffers of wicker-work for cylindrical gabions. The same change is insisted on by Girolamo Maggi, in book iii. chap. 20, of the *Fort. delle Città*, and with similar reasons urged for its adoption. A modern Italian author quoted in the same volume, (p. 388,) attributes the invention of the cunette to Jacopo Lanteri in 1565, whilst that work is to be found distinctly described and recommended by Albert Durer, 1527, and by Francesco of Siena in the previous century. The casemated caponières, and angular towers of Montalembert, are only enlargements of the *capannati* and keeps of the last-mentioned engineer.

NOTE Q.—PETER NAVARRE.

Peter Navarre, once famed over Europe as the first engineer of his time, was born of an obscure family in Biscay after the middle of the fifteenth century, and spent his youth as a mariner. Enlisting in the Genoese ranks, he was present at the siege of the hill-fort of Sarzanella,† held by the Florentines in 1487,‡ and witnessed there the first recorded attempt to apply gunpowder in mining.

Next entering the Spanish army, he rose to distinction in King Ferdinand's war against the Moors, and on the capture of Velez-Malaga (1487) ‡ he was made governor of the place. Peter afterwards accompanied the great Gonsalvo on his expedition to Italy (1500,) and in the siege of the principal fortress of Cephalonia, captured from the Turks after a resolute defence of fifty days, he repeated the trial of the mines which he had witnessed in his youth, but without marked success. He continued to distinguish himself in the war then in the south of Italy, directed against the French, (who were for a time commanded by our countryman Stuart of Aubigny ;)§ and at Naples, in 1503, the complete success of his mines in the successive capture of the castles Nuovo and Del Ovo marked an epoch in military history, and raised him to the highest reputation. The galleries under the latter fortress, which stands in the sea, were driven from covered boats which Peter constructed for the occasion.

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* New series, vol. i. 1851.

† The forts of Sarzana, Sarzanella, and Pietra Santa, in the vicinity of Lucca, are mentioned in *Guicciardini* (book i.) repeatedly, as bones of contention between the Genoese and Florentines.

‡ There seems some inconsistency in these two dates being the same ; but I cannot explain it.

§ "Obegnino suam aciem promovente neque Siculi nec Hispani equites Scotorum cataphractorum vim tulerunt, quin celeriter terga darent."—Paul. Jov., *Vita Consalvi Magni.*

Mézéray, in his *History of France,*[*] attributes these works to one Francis George, an architect of Naples. But there can be little question that this is a confused allusion to Francesco di Giorgio of Siena,[†] who had *written* on the application of gunpowder to mines twenty years before, and whose theory probably suggested the application to the anonymous Genoese engineer before Sarzanella in 1487.

The same year Peter took by assault Monte Cassino from the French, and greatly contributed to complete their expulsion from the country. He was rewarded with letters of nobility, and an investiture of the county of Alvetto, in the Neapolitan territory.

Returning to Spain, Navarre was sent by Cardinal Ximenes in command of an expedition against the piratical Barbary States. At first he had great success, capturing Oran, Bugia, and Tripoli. But in an attack on the island of Jerba, in the gulf of Cabes, during the month of August, his troops, suffering intensely from heat and thirst, were completely beaten, and, in the attempt to re-embark, suffered heavy loss from the Moorish cavalry. With some 3000 men who remained of his forces he passed over into Italy, and held the post of captain-general of the Spanish infantry in the league then formed (1511) by the Pope, the Venetians, and Ferdinand of Aragon, to expel the French from Italy. In the attack of a small fort called the Bastillion della Fossa, Peter carried two wooden bridges across the wet ditch under the fire of the garrison, and took the place by storm. Bologna was invested, (Jan. 1512,) and he there drove a mine under a part of the rampart on which stood a little chapel called Barbacana. A singular chance deprived the besiegers of success,[‡] which the defenders interpreted as a miracle in their favour. Three months afterwards, at the battle of Ravenna, the confederates were completely defeated, and Peter was made prisoner. Ferdinand, attributing the loss of the battle to Navarre's conduct, refused to pay his ransom, rated at 20,000 ducats. After he had remained a captive for upwards of two years, Francis I. offered him service, and discharged the ransom. Peter, having first written to the king of Aragon, to justify his conduct and renounce the estates which had been bestowed on him, accepted the offers of Francis, and, having raised 10,000 Basques and Gascons, accompanied that prince in his invasion of the Milanese. In the passage of the Alps, Navarre's skill as an engineer did good service. After directing several minor attacks, and distinguishing himself at the fierce battle of Marignan, one scene of Bayard's most brilliant achievements, he laid siege to the castle of Milan. In conducting this operation, Navarre appears to have united the ancient mode of mining with that which had gained for him so great a name, as at

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[*] Quoted by Allent, *Hist. du Génie*, 667.

[†] See NOTE E.

[‡] "At last the mine was accomplished, and the armie standing in order of battell to go forthwith to the assault, for the execution whereof with greater strength the vauntgard was revoked. Peter of Navarre caused fire to be put to the mine, which with so great noyse and furie blew up so high the wall and chappell, that in that space and division was made open to those without the intralls of the citie within, together with the maner of the souldiers prepared to defend it: but falling eftsoones downe againe, the whole wall tooke the same place from whence the violence of the fire had driven it, and was so rejoyned and knit againe as if there had not bene any separation or removing at all."—Fenton's *Giucciardini*, book x. Allent (*Hist. du Génie*) mentions a circumstance exactly similar which occurred at the demolition of Fontarabia in 1795.

Constantinople, in the previous century, the Turks had united the ancient and modern artilleries. At least, it is difficult to conceive how the hooks and rams mentioned in the account could have been used in combination with gunpowder.*

At Brescia, his "*accustomed remedies*" † of sapping and mining were baffled by the numerous retrenchments which the garrison had constructed within the breach.

During the truce which followed the treaty of Noyon, (1516,) Peter Navarre returned for a time to the element on which he had commenced life forty years before, being commissioned by the king (1519) to cruise on the Mediterranean with twenty galleys, in the ostensible view of repressing the Barbary pirates, but mainly to watch the movements of the Spaniards. War breaking out again in 1521, the French rapidly lost their conquests in Lombardy, and Genoa was invested. Peter, despatched by King Francis to its relief, entered from the seaward, and had scarcely landed when the Imperialists, making an unexpected assault, carried the city, and he remained a prisoner. Three years he now passed as a captive in the Castel del Ovo, which his genius had won for Spain.

Restored to liberty by the treaty of Madrid, and again at the head of 10,000 infantry, he accompanied Lautrec in his expedition to Italy as captain of the new league against the emperor which followed the sack of Rome. We find Peter still acting successfully as engineer at the siege of Alessandria and other places in the north, at Aquila, Melfa, the castle of Venosa, &c., in the centre and south of Italy. The army intrenched themselves before Naples, and carried on the siege prosperously for a time; but, ravaged by pestilence, deserted by the auxiliary Venetian fleet, and Lautrec carried off by disease, which prostrated most of the other generals, they attempted a retreat, and were compelled to surrender. Peter Navarre, thus a third time prisoner, did not survive many days. According to some accounts, he perished of the prevailing pestilence; but others relate that he was smothered in prison by command of the emperor. "*Ce fut mal faict*," says Brantôme: not (he goes on to say) that it mattered much to him, an aged prisoner, shattered and worn out; but, had he been spared to the leisure of captivity, he might have edified future generations with discourses on his art, or memoirs of what he had seen and done—a project, indeed, which he was said to have entertained. In this regret we may well join, for few lives have been so eventful, and replete with strange vicissitude. The nephew of the great Gonsalvo buried him by the side of his leader Lautrec, in the church of Santa Maria della Nova, and erected over him a marble tomb, with the inscription which is printed at the head of Chap. IX. of this book.

Peter introduced countermines as well as mines of attack, and provided for the former in his renovation of Castel del Ovo after its capture, and in the castle of Salzas in Roussillon, which was fortified by him. The practice spread rapidly, and in 1509, at the defence of Padua, we find countermining successfully practised by the Venetians.* It was developed on an enormous scale at the siege of Rhodes by the Turks in 1522, as well as at their attack on Vienna in 1529; and had spread to India in the reign of Akbar, (1567,) if not sooner.†

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* "Having won a murdring house [see *Casemate*, in Glossary] upon the castle ditch, which upon the flanke side had his prospect upon the gate of Coma, and afterwards approching nearer the castle wall by the helpe of pavisses and engines of wood, he began to worke a myne within the sayd ditch; and when he had removed the defences, he began to labour more mynes, taking away, with the helpe of his engines, a great pave or space of the wall on the flanke of the castle, and applyed his hookes and rammes, to make it fall at the same instant that he put fire to his mynes."—Fenton's *Guicciardini*, book xii.

† *Guicciardini*, book xii.

Paulus Jovius describes Peter Navarre as retaining, in his dress and countenance, traces of his homely origin, and with this his portraits do not disagree.

(Fenton's translation of Guicciardini's *History;* Paulus Jovius, *Elogia Virorum bellicâ virtute illustrium;* and also, *Vita Consalvi Magni;* Allent, *Hist. du Corps du Génie*; Brantôme, *Capitaines Célèbres.*)

NOTE R.—ANCIENT INDIAN SAPPING.

The following extract gives a curious description of sapping and mining as practised in India in the sixteenth century:—

In 1567, Akbar "having invested Chittoor, employed five thousand workmen of different descriptions to conduct the siege. The approaches were made by *sabat,*‡ a description of defence for the besiegers *peculiar to India.* The *sabats* are constructed in the following manner:—The zigzags, commencing at gunshot distance from the fort, consist of a double wall, and, by means of blinds or stuffed gabions covered with leather, the besiegers continue their approaches till they arrive near the walls of the place to be attacked. The miners then proceed to sink their shafts, and carry on their galleries under ground for the construction of mines, in which having placed the powder and blown up the works, the storming party rushes from the *sabat* or superior galleries, and assaults the place. On the present occasion, two *sabats* or superior galleries having been constructed, two mines were carried under the bastions at different spots, and they were both fired at the same time," &c.—Briggs' Translation of Ferishta's *History of Hindostan,* ii. 229. Again, at Ahmednuggur, in 1596, the besiegers are described as opening their trenches, and carrying on approaches by raising mounds, erecting batteries, and sinking mines; and were vigorously met by countermines on the part of the garrison.—*Ibid.,* p. 272.

NOTE S.—SIR FRANCIS VERE.

Sir Francis Vere, one of the most eminent of English captains before the age of Cromwell, was born in Essex, in the year 1554, of the noblest English lineage, being grandson of John, fifteenth Earl of Oxford.§

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* *Sketches of Venetian History,* ii. 214.

† See next Note, R.

‡ In Richardson's *Arabic and Persian Dictionary, sabat* is defined to be "A scaffold or floor between two outer walls, under which there is a lane or passage." But the resemblance to *sap* is certainly remarkable.—H. Y.

§ "I heard a great peer of this realm, and a learned man, say, when he lived, there is no king in Christendom hath such a subject as Oxford. And well might this be said, for De Vere came in with the Conqueror, being then Earl of Guynes. By Maud the Empress he was created Earl of Oxford, the grant being *Alberico Comiti;* so that he was clearly an earl before. . . And yet Time hath his revolutions: there must be a period and an end to all temporal things—*finis rerum*—an end of names and dignities, We find no record of the first thirty years of his life; but, as he was at that age still an esquire merely, it is not likely that he had previously enjoyed any opportunity of displaying his great military talents. In 1585-6, he crossed to the Low Countries as one of the leaders of the force which accompanied Leicester to the aid of the United Provinces. He first distinguished himself at Sluys, when attacked by Alexander Farnese, Prince of Parma, in 1587. This town was the general import depôt for French wines, and on that account was surrounded by a vast number of cellars and subterranean vaults, which became the scene of constant mining and countermining, and rendered the defence excessively harassing to the small garrison. The Spanish general granted them most honourable terms, declaredly on the ground of their resolute resistance, and the heavy loss which he had sustained—forty-three of his captains having fallen, besides many other officers. Vere, next year, was present at Bergen-op-Zoom, when successfully maintained by Col. Morgan and an English garrison against the same celebrated captain; and for his services on this occasion he was knighted by Lord Willoughby, who had succeeded to Leicester's military command. In 1589, having 600 of his Englishmen with Prince Maurice in the isle of Bommel, when Count Mansfeldt was making large preparations to pass into the island with 12,000 men, Vere displayed so much judgment and energy in intrenching the place, and planting his artillery to the best advantage, that the count desisted from the enterprise. In the same year he twice accomplished the relief of Rhinberg, carrying in each time a convoy of provisions in the face of the besieging army. The first time, he took them by surprise; but on the second occasion, he engaged the Spaniards, and, beating them with great disparity of numbers, forced his way into the town. His horse was killed with a pike-thrust, and he was himself wounded in the leg. In 1590, being despatched by the States, with 1200 men, to the relief of the castle of Litkenhooven, he found it blockaded by the enemy, who had constructed a square bastioned fort to command the entrance. The fort "was reared of a good height with earth, and then with gabions, set thereon, of six foot high;"* and Vere had brought neither cannon nor scaling-ladders; but he made his assault on the four angles simultaneously, and carried the work. On his way back to headquarters, he determined to make an attempt on a fort, "with four very royal bulwarks," which the Spaniards held near Wesel, in the principality of Cleves. With extemporised scaling-ladders he made two gallant assaults, but was unsuccessful. Whilst preparing

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and whatsoever is terrene;—and why not of De Vere? For where is Bohun? Where is Mowbray? Where is Mortimer? Nay, which is more and most of all, where is Plantagenet? They are entombed in the urns and sepulchres of mortality! Yet let the name of De Vere stand so long as it pleaseth God."—*Chief-Justice Crewe*, in L. Campbell's *Lives*, i. 373.

* Sir F. Vere's *Commentaries*, p. 14. It may be remarked here, that though gabions of the size mentioned here are unknown in present practice, in the sixteenth and seventeenth centuries this was the usual dimension. Maggi (*Fort. delle Città*, iii. 25) speaks of the French, at an attack of Perpignan, using a double row of gabions, six feet in diameter, and eight feet high. In Erard's *Fortification*, (1594,) in most of the engravings of sieges during the seventeenth century that I have seen, and in as late a work as the *Military History of Eugene and Marlborough*, (1736,) one finds all batteries represented as formed of these large gabions, generally one to each merlon. See also, at the end of this book, the vignette from a contemporary view of the siege of Grave, (1584.)

for a third, the commandant wrote to complain that Vere had given the assault without summoning; and that they were quite ready to yield, if he would do them the honour of showing a piece of ordnance. To gratify this punctilio, Sir Francis got a gun of some kind out of the next town, and placed it in battery: next morning, his summons was promptly complied with.

Vere's reputation must by this time have been considerable, for in this year, (1590,) before Elizabeth had given up the idea of appointing an English successor to Lord Leicester as governor of the Low Countries, Sir Francis was spoken of as a candidate for that high post, along with Lord de Grey and Sir John Norris.*

In 1591, accompanying Prince Maurice to the siege of Zutphen with the English auxiliaries, (of whom he appears to have had the chief command from about this time,) he made himself master of a "sconce" which had cost Lord Leicester heavy loss in his attack of that town, (the same operation in which Sir Philip Sydney fell,) by disguising some picked soldiers as country-folks with baskets of eggs and vegetables, each man carrying concealed arms. This stratagem gained the redoubt without the loss of a man. At the ensuing siege of Deventer, the bridge thrown across the river, which served as a wet ditch to the place, proved too short, and stood high above the low quay which ran below the breach. The leading ranks were so pressed on from behind, that they were obliged to leap the gap; but not being supported, they were driven back, and many drowned. Maurice was at first inclined to abandon the enterprise, but at Vere's instigation he reopened the batteries, and the town capitulated next day. The same year, whilst Parma was besieging the fort of Knodsenburg, which commanded the ferry at Nimeguen, Vere formed a plan for bringing his troops to an engagement, which was eminently successful. The Spaniards were drawn out of their lines, and so beaten that the Prince raised the siege, though he had almost reached the escarps of the place. In 1592, we find Sir Francis mentioned as a member of the standing council of war attached to Prince Maurice. The first operation of the campaign was the siege of Steinwyck, at which he was wounded. The place was enabled to make a long resistance, on account of the difficulty of breaching the stiff clay of which the ramparts were composed. It appears to have been one of the latest occasions on which the "*mounts*," or great cavalier batteries, were used in attack; and even the rolling timber towers of classical times were revived by a Dutch captain, with utter failure.† Gertruydenburg was taken the next year. Here Prince Maurice introduced the practice of making the troops handle the spade and pick, with extra working pay, according to our present system. The elaborate circumvallation which was thrown up on this occasion was a marvel to contemporaries, and was visited as a sight by the Dutch dames. Previously, intrenchment had usually been executed either by peasants pressed from the surrounding districts, or by professed pioneers. * At this siege, also, Sir Francis Vere distinguished himself by a dashing engagement with some of Mansfeldt's parties, which were hovering round the investment. In 1593, we find him posted at Zutphen, to watch the motions of the Spanish army manœuvring in the western provinces. The same year he was authorised to raise an additional English regiment for the service of the States; and probably on this occasion he took his seat in Parliament, to which he had been returned the year before as member for Leominster.

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* Van Metteren, *Hist. des Pays Bas*, livre xvi.

† Van Metteren, xvi. One of the mounts on this occasion was nineteen feet high. The tower was constructed with ship masts, of nine stories, each story twelve feet in height; and the whole was moved on wheels or rollers up to the edge of the ditch, where at first it enabled the musketeers to drive the defenders from the ramparts, and even from the streets of the town. But two guns brought to bear on it soon knocked the two top stories to pieces, and then no one would venture on it. The inventor was Captain Cornput of Breda, who had distinguished himself in defending the same town of Steinwyck in 1580. The Royalists, during the civil war in 1645, made a similar engine for the attack of Canon Frome, near the Malvern Hills; but it was captured by the Parliamentary troops before it could be used.—See Grose's *Mil. Ant.*, i. 385.

In 1596, Vere was summoned from the Low Countries to accompany the expedition to Cadiz, or "Calis Journey," as it was called, under the Lord Admiral Howard and the Earl of Essex. He took with him two thousand picked men of the English auxiliaries, and was appointed Marshal † of the land-forces, and Vice-admiral of Essex's squadron. The success, ample as it was, of this expedition, (which Macaulay ‡ calls "the most brilliant exploit that was achieved on the Continent by English arms, during the long interval which elapsed between the battle of Agincourt and that of Blenheim,") would have been still more complete, but for the divided authority of the commanders. Vere was engaged with his ship in the fight with the Spanish fleet, "having till that time," he says, "been a stranger to actions at sea;" and with his Low Country veterans played a prominent part in the ensuing capture of the town—that town which has so often echoed from landward or seaward with the thunder of British victory.

On a winter day,§ early in the next year, we find Vere again in the Netherlands, aiding Prince Maurice with his usual gallantry and vigour at the battle of Turnhout, the most important success yet gained over the Spaniards in the field.||

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* Thirty years before, we find Maggi (*Discourse on Field Intrenchments*) recommending that those of the soldiers who were *not ashamed* should work, according to the practice of the ancients; evidently not considering it a duty binding on a soldier. At Spinola's attack on Breda, 1625, it appears to have been optional. The working pay was a great object to many; but some there were too proud to dig, and not ashamed to beg. In the sieges of Frederic Henry of Orange, the soldiers appear to have worked on a sort of contract, their extra pay being cut if the work was not completed by a set day. Father Daniel, quoting Montluc, mentions that marshal as having employed his troops on intrenchments in blockading Boulogne, and that the other soldiers used to abuse them as they returned from their work. At the siege of Amiens, (1597,) Henri IV. made his men work in the trenches, paying them so much per toise, and allowing the survivors the wages of those who fell. Louis XIII., at St Jean d'Angely, (1621,) did the same.—*Histoire de la Milice Françoise.*

† The Marshal was chief of the staff, and ranked next to the General-in-chief, unless when a Lieutenant-general was appointed.

‡ Essay on Lord Bacon.

§ "The night (before the battle) was very cold, insomuch as the Count Maurice himself, going up and down the quarter, with straw, and such other blazing stuff, made fires in some places with his own hands by the corps-du-guard. Sir Robert Sydney and I got us into a barn thronged with souldiers to rest, because there was no sleeping by the Count Maurice, who was disposed to watch, whence I also was called to attend him."—*Commentaries*, p. 73.

|| A medal was on this occasion struck by the States, and presented to the captains and others distinguished in the action.—Van Metteren, livre xix.

In the summer of 1597, he again went as Marshal with Essex on what was called the "Island Voyage"—a resultless expedition to the coast of Spain and the Azores. [*]

After the return of the expedition, Sir Francis, being in great favour with Elizabeth—who, "as she loved martial men, would court this gentleman as soon as he appeared in her presence,"[†]—applied for the vacant government of the Brielle, one of the towns temporarily made over to England by the States. "Her Majesty, *as her manner was*, fell to objecting that he served the States, and that those two charges could not well go together." [‡] However, in 1598 he obtained his wish, and in the end of that year was established in the government.

In 1599, when a Spanish invasion of England was threatened, Vere was recalled in haste, and appointed Lord-Marshal. It is said, also, that at one time it was proposed to make him Lord-Deputy in Ireland.

In 1600, he commanded one of the three corps into which Prince Maurice's army was divided in Flanders, and was in charge of the advanced division on the Sandhills at the memorable battle of Nieuport, (5th July.) After making head for a long time, with great skill and gallantry, against the superior force of the Archduke, Vere received two shots in the leg and thigh in immediate succession, and his men were compelled to retreat. This they did, however, in such order, that he noted it as a good sign to his Lieutenant-colonel, Sir John Ogle, at the time. Just then his horse was shot under him, and he was with difficulty rescued. He rallied his Ragged Regiment, as it was called, [§] on the guns, still continuing to give his orders, till he saw the tide of victory decidedly on the turn.

In 1601, Ostend being besieged by the Spanish army under the Archduke Albert, Sir Francis Vere received a special commission from the States to command their forces in and about that fortress, having first been deputed to Queen Elizabeth to obtain a levy of new auxiliaries. He assumed the government of the beleaguered city, 11th July 1601. During the time Vere was in command, he designed and carried out extensive new counterworks, made a thorough repair of the old ramparts, excavated a new harbour, where the access of succours was better protected from the enemy; repelled, with very heavy loss to the Spaniards, several desperate assaults ; and, finally, on a general relief of the garrison, he left the city much better able to defend itself than when he entered, in spite of the 160,000 shot which the besiegers were said to have fired into the town during the eight months that he held it. [||] During

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[*] Here is a picture of Essex and his staff at Villafranca in the islands, when the Marshal was making a report to him of the enemy's movements :—"His Lordship made no answer, but called for tobacco, seeming to give but small credit to this alarm ; and so on horseback, with those noblemen and gentlemen on foot beside him, took tobacco, whilest I was telling his Lordship of the men I had sent forth, and the order I had given them. Within some quarter of an hour, we might hear a good round volley of shot betwixt the thirty men I had sent to the chapel and the enemy, which made his Lordship cast his pipe from him, and listen to the shooting, which continued."—*Commentaries*, p. 62.

[†] Sir Robert Naunton, quoted in Preface to the *Commentaries*.

[‡] *Commentaries*, p. 69.

[§] Fuller's *Worthies*.

[||] "The bulwark was by this time so thick stuck with bullets, that the ordnance could scarcely shoot without a tautology, and hitting its former bullets, which, like an iron wall, made the later fly in pieces up in the air : yea, the bullets in it were so many the defence he had been severely wounded in the head, and was compelled to retire into Zealand for a month. At one time of the siege, his garrison being greatly reduced, and expected aid not arriving, Vere took the questionable step of entering into sham negotiations,* during the preliminaries of which he completed some necessary works, and put off time till he received succours from Holland. Sir John Ogle, his hostage, might thank the Archduke that he was not hanged. This affair created great suspicion among the Dutch, with whom he was not popular.

The defence of Ostend was the crown of Vere's great services. † He made one more campaign as General under Maurice in the summer of 1602, and was again severely wounded in the cheek and neck, at the siege of Grave, in August of that year. He was confirmed in his government of the Brielle on the accession of King James. After this, we find no further mention of his actions. Peace being concluded with Spain in 1604, his services in the field were no longer required. As far back as the battle of Nieuport, he had been long held, he tells us, by a dangerous disease ; and shattered, as he must have been, by his numerous wounds, ‡ probably he took no further part in active life. He died in England, 28th August 1608, and was buried in Westminster Abbey, where his widow (the daughter of John Dent, citizen of London) erected a monument to him, on which he is termed Governor of Brielle and Portsmouth, General-in-chief of the English forces in Belgium.

The *Commentaries* of Sir Francis Vere were handed about for many years in MS., and copies of them were in the hands of Fairfax, Skippon, and other eminent men of that age. They were published at Cambridge in 1657. The work contains detached narratives of the most important of Vere's services, written in a very clear and manly style, with many interesting incidental touches from the life. It breaks off abruptly in the relation of the defence of Ostend, and a continuation of this is added by other hands. The greatest fault of the book is, that there is so little of it. But it betrays some disposition in the author to arrogate to himself the merit of all actions in which he was engaged, (a failing to which military men seem peculiarly prone,) and something, perhaps, of a jealous temper. There was a good deal of bad feeling between Vere and Raleigh from the time of the Cadiz expedition, if not sooner. But this did not hinder the illustrious survivor from bearing noble testimony to his rival's merit in his *History of the World.* Speaking of Elizabeth's parsimony in rewarding military services, he says :—" As all her old captains died poor men, so those of a later and more dangerous employment, whereof Norrice and Vere were the most famous, and *who have done as great honour to our nation* (for the means they had) *as ever any did*—those, I say, with many other brave colonels, have left behind them (besides the

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that they left not room to drive in palisadoes, though pointed with iron ; and some there were that would have undertaken to make the bulwark new, if they might have had the bullets for their pains."—*Continuation of the Siege of Ostend.*

* ———— " Dolus, an virtus, quis in hoste requirat ?"
Virg. *Æn.*, ii.

† " The bone he had to gnaw," says Sir John Ogle, " required as good teeth as any were in Hannibal's head to break it ; and had not his been such, all the hands we had there could not have plucked it out of our own throats."

‡ Received at Rhinberg (1589,) at Steinwyck (1592,) two at Nieuport (1600,) at Ostend (1601,) and at Grave (1602.)

reputation which they purchased with many travels and wounds) nor title nor estate to their posterity." *

"Sir Francis," says Fuller, "was of a fiery spirit, and rigid nature, undaunted in all dangers, not overvaluing the price of men's lives to purchase a victory therewith."

Vere's younger brother, Sir Horace, was also a great and gallant soldier. He fought by the side of Sir Francis in most of his actions, and when in command himself, did feats of soldiership that drew warm praise from Spinola, the great leader of the enemy. He survived his brother for seven-and-twenty years, the steady friend and comrade of the Princes Maurice and Frederick-Henry of Orange. He was made a peer by Charles I. in 1625. "He had more meekness," says Fuller, "and as much valour, as his brother; so pious, that he first made his peace with God before he went out to war with man—one of an excellent temper." —"Sir Francis was more feared, Sir Horace more loved, by the soldiery. The former, in martial discipline, was often *rigidus ad ruinam;* the latter seldom exceeded *ad terrorem.* Both lived in war much honoured; both died in peace much lamented." †

The history of Vere's campaigns suggests a remark on the importance of fortresses, especially in those days of comparatively small armies. Here we have war carried on for twenty years and more, by several captains who were masters in their art, within a territory not exceeding in size Scotland south of the Forth—and even then only suspended by a truce. We should err in supposing that there was any dearth of hard fighting: the soldiers on both sides were thoroughly inured to war, and actions of gallantry were frequent, such as have never been surpassed. The excessive number of campaigns, before a definite result was reached, seems mainly due to the great number of fortresses which lay in the way at every step, and the powerful resistance which they made with very small garrisons.

(*Commentaries* of Sir Francis Vere; Van Metteren, *Histoire des Pays Bas,* 1618; Fuller's *Worthies; Penny Cyclopædia,* &c.)

Note T.—Turkish Engineering.

The Turks did not make lines of circumvallation in their sieges. Montecuculi describes their trenches of attack as "not conducted by the shortest direction, with flanking redoubts at intervals, but drawn in curving transverse lines, parallel to the place approached, and multiplied one behind another, in such a fashion that they cannot be enfiladed from the fortress, or damaged by cannon." ‡ Contemporary writers describe their trenches at Vienna, in 1683, as formed of short curves, overlapping one another like the scales of a fish. These were their places of arms, or parallels, with the numerous boyaux connecting them together. The approaches (properly so called) were *wormed,* or serpentine, with very close sinuosities—in good soil not deviating far from a straight line. When necessary, they were revetted with stones, and, as they approached the place, blinded over with beams and turf. These trenches were made a great deal deeper than ours. At Famagosta, (1571,) we are told—doubtless with a little exaggeration—so stupendous were their exertions, that, along a course of three miles, in part of which a hard rocky soil was to be excavated, not only the infantry, but even horsemen, might advance, protected so that scarcely the points of their lances could be seen from the city towers. At Vienna, in 1683, they were twice a man's height in depth. The soldiers used to dig themselves nooks and lodgments in the front of the parallels, for shelter during rain; and apartments for the principal officers were excavated, those for the Vizier and Pashas being sometimes sumptuously carpeted and cushioned.

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* *History of the World,* book v. chap. 6, § 2.

† Fuller's *Worthies*—Essex.

‡ *Mémoires,* ii. 5.

Occasionally they used redoubts as well as parallels for the protection of the attack. Thus, at Famagosta, the approaches were defended by ten forts, constructed of a strong framework of oak, filled up with earth, ashes,* and woolpacks. When a place was obstinately defended, they raised against it great mounts of earth, from which to pour fire into the place, and to see in reverse all the besieged works. These, too, they sometimes commenced at a distance, and pushed before them shovelful by shovelful to the edge of the ditch.† These mounts were particularly remarkable at the siege of Rhodes, in 1522.

Mining was a great engine of attack among the Turks—witness the siege of Rhodes, the two sieges of Vienna, and that of Candia, (1660-1669.) At Rhodes, they used both the ancient and the modern modes of mining, as Navarre had done in some of his attacks. At Vienna, in 1683, they were said to have lost 16,000 miners. But they had also abundant artillery, and some of enormous size—80 to 120 lb. calibre was not uncommon; and on the Dardanelles they had guns, we are told, which carried stone shot of 1100 lb. weight. Their large guns were not always carried about with their armies; but when a siege was to be undertaken, they took gun-metal with them on camels, and cast such ordnance as was required at the adjoining villages. In their earlier sieges, they fired great bombards, projecting stones of huge weight, which, falling into the city, might destroy the buildings. At Rhodes, says Rycaut, these proved of more terror than danger, for with 200 such shot there were but ten men slain.

The ditches were filled by swarms of the troops called *Asapes*, casting in woolpacks, sandbags, fascines, timber, and what not. The Janissaries marched to the assault without firearms, which they used to say made more noise than effect, and were only good to fire from behind a wall. The Turks long adhered to the use of the bow, and covered their assaults with an iron sleet of arrows almost inconceivable. At Vienna, in 1529, the discharge of arrows was so heavy and incessant that, through the town generally, no one could walk abroad with safety. At Scutari, in 1478, we are told, such was the closeness of the arrowy shower that a wretched cat, which was scared from its hiding-place, fell pierced by eleven shafts at once ! Three or four arrows were in many places found transfixing one another; and the wood of these missiles supplied fuel to the city for several months !

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* The *ashes* were probably derived from old brick-kilns, which generally abound round the skirts of Eastern towns. Being the accumulation of centuries, these form vast mounds, which have often accommodated besiegers with sites for the establishment of commanding batteries. The *Mundee Awa*, a mound of this description, afforded a place for the first battery in the British attack of Mooltan, (December 1848,) and others of the kind had been turned to the same account by Runjeet Singh, when he took the place in 1818. Any one who has been at Cairo must remember such huge mounds adjoining the city walls. The prophet Jeremiah speaks of "the clay in the brick-kiln which is at the entry of Pharaoh's house in Tahpanhes," (xliii. 9.)

† In one of Czar Peter's sieges on the Turkish frontier, he is related to have conducted his whole approaches in a manner similar to this. With his large army encircling the place, he set them to dig a parallel in a ring round it, and then to converge towards the town from every part of the circumference, casting the excavated earth before them, so that the circle contracted, and grew in height continually up to the edge of the ditch. Bousmard (i. 2) tells a story of a Turkish vizier who was consulted regarding the attack of a Christian fortress. "Come to me," was his only answer, "without putting a foot on my carpet." The enigma was solved by the messenger's rolling up the ample carpet to the feet of the vizier. This illustration seems most applicable to such an attack as this of the Czar.

The Janissaries never worked at intrenchments. Such work was done by the *Asapes*, an inferior class of soldiers, whose lives were sacrificed in vast numbers at sieges, they being regarded very much as fascines or woolpacks, to be thrown into a ditch as a bridge for their betters to pass over.

The Turks used not to relieve their working-parties or guards during a siege. When once posted, there they remained till the business was finished, their food, water, fuel, &c., being brought to them.*

On a march they sometimes employed the *Spahis*, or horsemen, to throw up their field-works. These, marching rapidly, had the camp intrenched by the time the infantry came up.

Like the Sikhs, they used often to make extemporaneous burrows as a defence against cannon-shot; every man having his own, where he remained as if in armour till the cannonade was over.

They used trenches in the attack of field-works as well as of fortresses. These are described as having no appearance of regular lines; "only the ground was cut up and down in deep trenches without any art or form; but as they pushed these trenches continually further and further, they seemed to do their business very effectually." †

When Belgrade was besieged by Eugene, in 1717, with regular lines of circumvallation and countervallation, the Turks laid siege to him with their trenches of approach, affording an example of *obsidium in obsidio.*

In the field, the Turks frequently intrenched themselves with the waggons which accompanied the army. When the sultan himself was present, these waggons and the camels were formed into an inner fence encircling the royal pavilions. At the great battle of Zenta,‡ (a battle in its features singularly resembling that of Sobraon,) the Turkish works on the Theyss, which Eugene stormed, consisted of a double earthen intrenchment and an outer barricade of carriages. This carriage-intrenchment was a favourite practice of John Ziska's Bohemians, of the Poles, and of all the Sclavonic nations; and in the fifteenth century we find it constantly employed by Charles of Burgundy. §

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* *Montecuculi*, ii. 5. Sir J. C. Smyth, quoting this, remarks:—"Those who have witnessed the little labour performed by soldiers, the negligence in general of in other respects good officers when employed upon working-parties, the time lost in relieving detachments, and the hurry they are invariably in to be relieved, will perhaps agree that a medium between the two customs would be an improvement."—*Chron. Epit. of Wars of the Low Countries.*

† *Mil. Hist. of Prince Eugene*, ii.

‡ 1697. See a plan of the battle in the *Mil. Hist. of Eugene*, i. 43.

§ Philip de Comines.

We may conclude this note with some lively notices of Turkish campaigning from the *Letters of the Prince de Ligne*, which remind one strongly of some of our friends in the East.

They know, he says, but two tricks or *ruses de guerre*, and deem themselves extremely cunning when these are employed with effect. The one is to make a discharge of all their artillery in token of joy at a pretended battle won, or castle taken, nobody knows where; the other, to get one of their couriers captured with false intelligence on him, that twenty or thirty pashas are about to arrive with a reinforcement of 200,000 or 300,000 men. They never are fairly astir till ten o'clock, and scarcely ever do anything at night. In sieges, the artillery is worked by those who get up first in the morning, and who amuse themselves by discharging it. "The instinct of the Turks, which is better than the reason of the Christians, gives them expertness and capacity in all the occupations of war. But they have only the first impulse to any good purpose; they are not susceptible of a second reflection; and after having expended their moment of good sense, they border on the child or the fool."

(Lord Mahon's *Two Sieges of Vienna; Sketches of Venetian History; Montecuculi*, (vol. ii.;) *Mil. Hist. of Eugene and Marlborough;* Rycaut's *History;* Manesson Mallet, *Travaux de Mars, &c.*)

NOTE U.—BELIDOR.

Bernard Forest de Belidor, the son of a French officer, was born in Catalonia in 1697 or 1698. Being left an orphan when an infant, he was adopted and taken to France by another officer. In his youth he studied attentively the elements of mathematics; and before he was sixteen saw two sieges, (Bouchain and Quesnoy,) under the care of his protector's brother, who was an officer of engineers. He was shortly afterwards an assistant to Cassini and Lahire in their measurement of the degrees, and at a later period was appointed professor at the Artillery School of La Fère, founded by the Regent Orleans. Whilst Belidor held this he was endowed with a captain's commission, much to the dissatisfaction of his comrades in the new capacity, who grudged a uniform to a "counter-caster:"—

> "Forsooth a great arithmetician,
> That never set a squadron in the field."

Belidor made many experiments on gunpowder and military mining, for which opportunity was afforded by his position in the Artillery School. Before his time it was supposed that the result of a large charge of powder in a mine would be merely to blow out the mass of earth immediately above it, and that it would produce no lateral effect increasing in any proportion with the charge. But he proved by experiments, with charges varying up to 4000 lb., that craters were produced by explosion, the radii of which reached to nearly three times the line of least resistance, and destructive effect to a distance of four times that line.

With regard to artillery, he also proved that, with the large charges then used, a part of the powder was useless, not being fired before the ball left the gun. Some jealousy created by this discovery, or his communication of it to the minister, led to his dismissal from his professorship.

In 1742 he accompanied General de Segur as aide-de-camp on the campaign in Germany under Marshal Belleisle, and was taken prisoner at Lintz. He soon exchanged, and obtained his lieutenant-colonelcy. He served under the Prince de Conti in the campaigns of 1744 and 1746—the first in Italy, the second in Flanders—and did good service in both. He became a member of the Academy in 1756, and died holding the rank of Maréchal-de-camp and Inspector-general of Mines, in 1761.

Belidor published various works on mathematics, engineering, and gunnery, most of which long had great repute among military students. His principal work, the *Architecture Hydraulique*, in 4 vols. 4to, was published at intervals between 1737 and 1753. It long maintained its place as the most complete book of its kind; and engineers will still find it useful, especially in colonies, where the simpler mechanical processes of that age are sometimes more suited to the capacities of the artisans than the more elaborate methods of our time.

NOTE V.—CORMONTAINGNE.

—— Cormontaingne is supposed to have been born about 1692; but nothing is known of his early history, and even his Christian name has not been preserved. He was present at the siege of Fribourg in 1713, and (according to M. de St Paul) entered the engineer corps in 1716. He served at the sieges of Traerbach and Fribourg in 1734; at those of Menin, Fribourg, Tournai, Ath, and others, under Saxe, on the Flemish frontier, in 1744 and 1745—in some as chief, in the rest as major of brigade, or as brigadier—and was present at the celebrated battle of Fontenoy. He was afterwards engaged in the superintendence of the eastern fortresses of France, and in the construction of new works at Metz and other places, in which he introduced some of his improvements. He died Maréchal-de-camp and Director of Fortifications in 1752.

Extracts from his MSS. were long used as text-books in the engineer school at Mezières; but they were not published *in extenso* till the beginning of this century, (1806–1809.)* They contain a vast mass of useful details, with illustrations from his own experience. "Cormontaingne," says Noizet de St Paul, "was a man of singular industry, and distinguished by a justness of conception, a methodical intellect, and an exactness of ideas, which render his writings a treasure for students of fortification."

The method and precision of his ideas is illustrated by the statement that, at the attack of Fribourg, which he directed in 1744, all the operations on the ground were in exact conformity to Cormontaingne's written project and sketches — a circumstance probably without parallel in such works.

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* Viz.—one volume on *Permanent and Field Fortification*; a second on the attack; and a third on the defence—left incomplete by Cormontaingne, and made up from the notes of Fourcroy.

Cormontaingne made no pretension to invent a system. He only professed his aim to be to perfect the method of Vauban.

(Preface to the second volume of his works; N. de St Paul, *Traité Complet; Penny Cyc. Suppl.*)

NOTE W.—COEHORN.

Minno van Coehorn was born of a noble family near Leeuwarden, in 1632, (but according to the *Biographie Universelle* in 1641.) Having received a thorough mathematical education, he entered the service as a captain. He distinguished himself in the various sieges during the war of 1672-76, and at the sanguinary battles of Senef, Cassel, &c.; but in 1675, piqued at what he considered injustice on the part of the Prince of Orange, he made overtures of service to the French, which were warmly seconded by Vauban. William, however, compelled his return, by arresting his wife and children, and afterwards did all in his power to reattach him to his service. Coehorn subsequently refused several high offers from foreign princes. He commanded at Namur when besieged in 1692, and directed many sieges in that war, and in the commencement of the War of Succession. In the latter he served with distinction as a general officer also, forcing the French lines in the district of Waes, between the Scheldt and the sea, (1703.) The next year he died, (March 17, 1704,) when he had just been summoned by Marlborough to assist with his counsels at the Hague.

Coehorn published in 1682 a memoir on the fortification of the Pentagon; but his principal work, *New Fortification,* did not appear till 1702, and was translated into French two years after his death. He fortified many places in the Low Countries, of which Bergen-op-Zoom is a celebrated example, considerably less complicated than his paper projects—as must generally be the case when money has to be provided for such expensive works as fortresses are. It was a saying of Antony Deville, that, when a prince begins fortifying, "he should keep his eyes shut and his purse open."

The two great contemporary engineers were matched against each other at Namur in 1692, under the eyes of their sovereigns, Louis XIV. and William of Orange. Vauban won the great game, capturing the place, which Coehorn commanded, and had himself fortified—a discomfiture from his illustrious rival which the Dutch engineer took grievously to heart, notwithstanding the generous courtesy of Vauban. Indeed, he seems to have entertained a strong personal feeling of emulation towards the great Frenchman, and in the Preface to his "New Fortification" appears purposely to avoid mentioning his name.

Coehorn's system of attack was very different from that of the French engineer. The latter made his chief aim success with the least possible loss of life; the former, success in the least possible time. The one advanced on each work surely and steadily, intrenching each foot of ground; the other sought rather to abridge a siege by an overwhelming fire of artillery, seconded by frequent and audacious assaults, in which the loss was often most heavy. Against Bonn in 1703 (his last campaign) Coehorn, besides a large park of heavy artillery, is said to have employed five hundred of the small grenade mortars, which took their name from him on that occasion. The place surrendered in three days; but the system was by no means always so successful.

Coehorn's manners were plain and frank, his character upright and estimable. His son, Henry Casimir, rivalled him in knowledge and ability as an engineer, but was of a morose and eccentric disposition, and retired early from the public service. According to the *Biographie Universelle,* Coehorn was created a baronet by Charles II.; but I can find no confirmation of this in any list of the extinct or existing baronetage.

(Allent, *Hist. du Corps du Génie; Biog. Universelle, &c.*)

NOTE X.—MONTALEMBERT.

Marc Réné, Marquis de Montalembert, was born at Angoulême in 1716, deriving his descent from the same ancient family which had produced D'Essé the gallant defender of Landrecies and Terouanne, and leader of the French auxiliaries in Scotland during the regency of Mary of Guise.* After receiving a very complete education he entered the household troops at the age of eighteen, and in his first year's service was present at the siege of Kehl (1733), and in the next campaign distinguished himself at the attack of Philipsburg. He served afterwards with reputation in the French army, under the Marshals Broglie and Belleisle, which in the war of 1741-2 acted in Bohemia as auxiliary to the Elector of Bavaria against the Empress. Returning to Paris he gave himself to study, was made a member of the Academy of Sciences, and published several papers in their Transactions. About the same time he established founderies on a large scale at Perigord, and near Angoulême, for the purpose of casting heavy iron ordnance, which appears to have been previously little known in France. During the Seven Years' War he was attached as an accredited agent of his government to the staff of the Swedish and Russian armies successively, took part in the councils of the generals, and reported to the French ministry on all operations of the war. In the preface to his great work, he states that, for the forty-five years to which his service then extended, he had continually devoted himself to the study of all that bore on the military art; that he had made fifteen campaigns in Flanders, Italy, and the various countries of Germany; that he had been employed as Commandant in the Isle of Oléron when menaced by the English, after the capture of Belle-Isle in 1761; followed day by day the progress of the works in nine sieges; had visited and carefully scanned nearly all the fortresses of Europe; and had on several occasions been afforded the opportunity of carrying his principles of defence into execution, as at two places in Pomerania which he assisted to defend, and at the citadel of Oléron.

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* See *ante*, p. 82.

In 1761 he published the prospectus of his work on fortification; but the Duc de Choiseul, who was then minister, politely recommended its suppression, that the benefits of the Marquis's ideas might be reserved for France. The first volume (in 4to) did not appear till 1776, and it was followed at intervals in the next twenty years by ten others. From this circumstance, the work is not often to be met with complete. It is illustrated by numerous plates executed with unusual beauty, and the cost of its production must have been very great. In a late French book-list it is priced at 360 francs—£14—a much larger sum than it would be likely to fetch in this country. The Engineers as a body joined in condemning the work, and a very rancorous controversy arose on its merits. Carnot, then a captain of engineers, came in for hard knocks from both sides. The Marquis insulted the soldier-philosopher on account of an imagined disparaging allusion to his book; and the seniors of the corps had him cast into prison for presuming to eulogise it.*

In 1779 Montalembert was employed to construct a fort for the defence of the Isle of Aix. It was built entirely of wood, from a design of his own.

In his latter years he was reduced to great straits, having expended a large part of his fortune in his experiments, and in the publication of his projects. Like the Count de Pagan, he had lost an eye in his country's service; but the pension which he enjoyed for this injury was taken from him at the Revolution. He had also just claims on account of the cannon founderies which he had given up to the government; but these were never made good. Still the enthusiasm of the man in his favourite pursuits led him to retain the services of a draughtsman and a modeller, whom he employed in the construction of a noble series of models illustrative of fortification and artillery, which he presented to the Revolutionary government. Carnot retained his respect for the old aristocrat, and is said to have frequently consulted him when at the head of the war administration.

Montalembert died of dropsy March 29th, 1800, at the age of eighty-six. In 1770 he had married a lady of some reputation as an actress and an authoress. His conduct to her does not give us a high idea of his moral character. Having taken the Marquise to England in 1790, he left her there; and after his return to Paris, when the Revolution was fully developed, taking advantage of the fashionable spirit, he divorced his wife to marry the daughter of an apothecary.

The *Fortification Perpendiculaire* was originally intended to fill two volumes ; it professed to close with the fourth ; but to these supplementary dissertations were added, which swelled the number to eleven. Much of this bulk is due to large type and margin ; more to want of method, repetition, and enormous digression.

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* Carnot's letter disclaiming the offensive allusion contained the following passage:—"Had there been any ground for your suspicions, I should have misunderstood the first duties of honour and decency; I should have failed especially in that infinite respect which soldiers owe to a distinguished general. Believe me, there is no officer of engineers who has not learned with pleasure that the Marquis de Montalembert has fortified places as well as the brave D'Essé has defended them." "Your work is full of genius. Provided your casemates are known and proved, fortification will take a new form, and become a new art. Though the corps of Engineers has not the advantage of possessing you, we believe that we have no less the right of reckoning you among its most illustrious members. Whoever enlarges our knowledge, whoever furnishes us with new means of being useful to France, becomes our colleague, our chief, our benefactor." Montalembert apologised fully.—Arago's *Biography of Carnot.—North British Review*, May 1851.

The work commences with an essay asserting the superiority of the defence before the introduction of the bastion trace, and pointing out the evils of the latter. He proceeds to show how these defects might be in a great degree remedied in the manner indicated in the text, and to explain his system of construction for new fortresses, (*ante*, p. 137.) He then describes in much detail his *casemated caponière*—a great vaulted work, mounting three tiers of guns and musketry.

Suggesting improvements in the construction of square redoubts, he develops these in a series of splendidly executed plans, into permanent square forts of gradually increasing capacity and strength, furnished with retrenched and casemated cavaliers, keeps of masonry, caponières with earthen counterguards, and general envelopes having detached casemated escarps. These forts he names after the Bourbon titles, coming to his climax in the Fort Royal.

He also furnishes designs for triangular and circular forts, and exemplifies the application of his enceinte, and detached forts of these various forms, in combination. In his designs for marine batteries, his mania for casemate building is carried to an outrageous pitch.

In discussing the possibilities of attacking his Fort Royal, he shows that the endeavour to establish any battery against it would be exposed to a concentrated fire of 217 pieces, and would therefore be futile.

Other parts of his work contain projects for frontier lines, and lines of circumvallation, with various memoirs on the controversy excited by his schemes. The ninth quarto is more especially entitled *l'Art Defensif Superieur à l'Offensif*, but I have not seen the later volumes.

Looking at Montalembert's vast ranges of vaulted walls and galleries, one cannot but suspect some arithmetical legerdemain in the great cheapness claimed for them, as compared with ordinary constructions, even recollecting the margin acquired by suppression of counterscarp walls. But the truth of much of his doctrine is now largely admitted, and the spirit of his projects has moulded the great works executed in Germany since the peace. A comparison of Fort Alexander with his Fort Royal, (*Fort. Perp.*, vol. ii.,) and of Ingolstadt with his project for Cherbourg, (vol. iii.,) will show how closely he has been followed by the engineers of both Prussia and Austria.

NOTE Y.—CARNOT.

Lazarus Nicholas Marguerite Carnot, like Vauban a native of the Province of Burgundy, was born 13th May 1753, one of the eighteen children of an advocate at Nolay, who drew his descent from an old though not noble family in the duchy. He was originally intended for the church ; but showing a strong bias for mathematical studies, his friends obtained his admission into the school of Mezières, and in 1773 he entered on his first duties as lieutenant of the engineer corps—the only one then open to *roturiers*, or persons not of noble birth.

Previous to the Revolution he had reached the position of captain of engineers, and chevalier of St Louis, and had attained considerable reputation, especially as the author of a prize eloge on Vauban, read before the Academy of Dijon in 1783, and of an able and original essay on the application of power in machinery. A curious episode rose out of the former paper. A disparaging allusion in it being appropriated by Montalembert, then at open war with the engineers as a body, he replied by publishing an edition of the eloge with outrageously offensive notes. Carnot met this in a highly honourable spirit, disclaiming the allusion, and expressing his high respect for the works, ideas, and services of the hasty Marquis.* The latter made an ample apology. But it was now the turn of the seniors of the corps to take offence. Indignant that a junior and plebeian officer should dare publicly to eulogise projects which they had authoritatively condemned, a *lettre-de-cachet* was procured, and Captain Carnot thrown into the Bastille.

Even under the old régime, in his essay on Vauban, Carnot had given vent to bold doctrines on the subject of taxation, and when the Revolution broke out he adopted his principles with enthusiasm. In 1791, when in garrison at St Omer, he married the daughter of a rich merchant there; and this opened the way to his election as a representative of the Department in the Legislative Assembly. He soon was attached to the Committee on Military Affairs, and on the abolition of royalty was commissioned to reduce to obedience the armies of the Rhine and of the Pyrenees, which he effected with vigour and success. Returned to the Convention, again for the Pas de Calais, he voted for the death of King Louis with the "*phrase*,"† (according to his own account,) "In my opinion, justice and policy demand his death; but never did duty weigh so heavily on my heart."

Carnot was one of the first of the republicans to enunciate the doctrines of conquest and assimilation. In his reports to the Legislature, "ignoring" all the professions of moderation and non-interference with which the democrats had started, he declared that the Rhine, the Alps, and the Pyrenees, must be the boundaries of France; that the Republic could recognise in a foreign country no sovereign but its people, &c. In 1793 he became a member of the Committee of Public Safety, and in that capacity, spite of the stigma of the association, achieved matchless services for France. On him devolved the task of calling out and organising the military resources of his country. It was then in great danger. Threatened by the Allies on the Flemish and Rhine frontier, invaded by the Spaniards, with Toulon in the hands of England, and La Vendée in a blaze of successful insurrection, the burden on Carnot's shoulders was such as has rarely rested on a single man; but his elastic energy was equal to the load. During this time he devoted sixteen hours a-day to the duties of his office. He organised fourteen armies, gave them leaders selected from all ranks, provided arms and ammunition, furnished the generals with detailed instructions, read every despatch, and sometimes hastened himself to the scene of action. Thus Carnot was present at Houchard's defeat of the Allies at Hondschoote,

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* See preceding note on *Montalembert*.

† SIEYES.—"La mort *sans phrase*."

(8th September 1793,) and Jourdain's at Wattignies, (16th October,) where his energetic counsel and gallant personal example greatly conduced to the victory, and consequent raising of the siege of Maubeuge.

Compromised in the attempt of the Terrorists to recover power (May 1795,) he was denounced and nearly condemned, when Bourdon de l'Oise cast a shield over him, by the memorable words—"Decreterez-vous d'accusation l'homme qui a *organisé la victoire*?"

When the Directory was formed, Carnot became one of the Five, and again assumed charge of the War Department. In September 1797 he was proscribed and banished. His name on the roll of the Institute was erased, and replaced by that of Buonaparte. He resided in exile at Augsburg till the upset of the 18th Brumaire, when Napoleon sent for him to make him Minister of War. His strong and sincere republicanism, matching ill with the Consul's views, led to his resignation in 1801, and was consistently displayed by his strenuous opposition to the assumption of the imperial crown.

In 1809 his celebrated work (*Defense des Places Fortes*) originated in a request from the Emperor that he would draw up a special system of Instructions for the Governors of Fortresses. It was completed in four months.

The first part of the book contains several chapters enforcing the obligation of defending fortresses to the last extremity, denouncing the idea that surrender is inevitable, and the absurdity of calculations of the duration of a siege.

Copious illustrations of energetic or successful defence are detailed from ancient and modern history. The second part of the work enters into the details of a governor's duties in anticipation of being attacked, and during siege. The author's peculiar novelties, which have been indicated in the text, are contained in additional memoirs at the end.

During the prosperous years of the Empire, Carnot was mainly devoted to scientific pursuits as a member of the Institute, in which he had recovered his place, and as the author of various treatises in the higher mathematics. In 1814, when Napoleon was rushing to his fall, he most honourably offered his services. The Emperor immediately appointed him Governor of Antwerp, then menaced by the English under Sir T. Graham. He reached the city the day before bombardment opened, and held his post till submission to the new order of things was inevitable.

Carnot gave in his adhesion to the Bourbons, but was somewhat unreasonably mortified by the cold reception which he met with; and, during the Hundred Days, Napoleon had little difficulty in persuading him to accept a Portfolio, making him at the same time Count and Peer of the Empire—a dignity little consonant with his democratic principles, and perhaps with his wishes. After Waterloo, in the Legislature at Paris, when Ney, *le brave des braves*, was in despair, Carnot was the only man who preserved his courage, and took thought for the country. And when the abdication was announced, the old republican, who had stood forth alone to resist the establishment of the Empire, burst into tears. He was the only one of the Ministers of the Hundred Days who was proscribed. The Emperor Alexander treated him with consideration, and gave him a passport for the Russian states. After a short stay at Warsaw he removed to Magdeburg, where he passed the remainder of his days in literary occupations, and in superintending the education of one of his sons—I know not if the man who achieved such unenviable fame in 1848. Carnot died at Magdeburg 2d August 1823, aged seventy.

In character, as well as ability, Carnot towered above the swamp of blood and slime which preceded the rise of Napoleon. Christian virtue need not be looked for among the heroes of the French Revolution, but the virtues of the old Romans whom he worshipped, devotion to his country's service, and the abnegation of self in the paths to wealth and power, Carnot displayed in a very high degree. His life has lately been written in a strain of unmixed eulogy by Arago, a kindred spirit in his love of science and democracy. In justification of his complicity in the atrocities of the Committee of Safety, it is urged that all Carnot's time and thoughts were engrossed by the pressure of his own vast cares in the organisation of resistance to the external enemy; that the law required a multiplicity of signatures to every act of the Committee; and that to measures unconnected with his own department of administration Carnot's name was necessarily given blindly, and on trust; in short, that he knew his reputation must be sacrificed, and sacrificed it to serve his country. Perhaps a better defence, of his intentions at least, lies in the fact that he never was a member of the clubs, and that he was thoroughly hated by Robespierre. Still, we can scarcely believe that the surpassing ferocity of the Republican military code, and the murders of the Houchards and the Custines—men who had faithfully served the Republic to the best of their ability—could have been altogether without the sanction of the despotic War-Minister.

Carnot, when organising and directing armies, nominating and cashiering generals, was a simple Captain of Engineers. When in the Directory he had risen by seniority to the rank of major, and so remained till his appointment to Antwerp, when a single gazette lifted him through all the intermediate ranks to that of General of Division.

A posthumous addition to the treatise on the defence of fortresses was published at Paris in 1823, (*Memoire sur la Fortification Primitive,*) in which he seeks to re-establish the superiority of defence over attack by reverting to the concentric circular ramparts of primitive times.

Carnot was a poet in a small way, and a collection of his verses was published at Paris in 1821.

(*Biographie Universelle; Defense des Places Fortes;* Arago's *Biographie de Carnot,* reviewed in the *North British Review* for April 1851; Alison's *History.*)

NOTE Z—BOUSMARD.

Henri Jean-Baptiste de Bousmard was born in 1749, descended from a wealthy line of magistrates at St Mihiel on the Meuse. He was admitted to the school at Mezières in 1765, entered the Engineer corps in 1768, and was employed at different fortresses of eastern France till the Revolution. He was the author of various prize essays and memoirs on political economy, public education, and other subjects.

Elected to the States-General (or Constituent Assembly, as it was afterwards called) by the nobility of the Barrois, one of the subdivisions of Lorraine, he took his place among those who sought extensive reforms, but desired the preservation of the monarchy.

After the separation of the Assembly, in October 1791, Bousmard returned to his duties at Verdun. On the 30th August 1792 the Duke of Brunswick invested the place, and summoned it next day. "Resist him to the death? Every day of retardation precious? How, Beaurepaire, (asks the amazed Municipality,) shall we resist him? We, the Verdun municipals, see no resistance possible. Has he not 60,000, and artillery without end? Retardation! Patriotism is good; but so likewise is peaceable baking of pastry and sleeping in whole skin. Hapless Beaurepaire stretches out his hands, and pleads passionately—to no purpose." * The commandant sought escape from his perplexity by shooting himself; and his successor, with the advice of the Council of Defence, of which Bousmard was a member, capitulated on the 2d September. Bousmard must have had the scene at Verdun vividly before him when he wrote the sixth chapter of the fourth book of his Essay, *De la Bourgeoisie.* The Convention paid a tribute to the memory of the suicide colonel, and sent his successor to the guillotine. Bousmard saved his head by flight.

In exile at Wiesbaden, separated from his family, and from all access to such books as could aid him, he occupied himself for four years in the composition of his *Essai Général de Fortification*, probably the best existing view of the whole subject, as its clear and lively style renders it also one of the most readable books in the engineer's library. By the time the work was done Bousmard was reduced to great poverty, and he trudged on foot to Berlin, carrying his MS. and his baggage on his back.

The King, Frederick-William II., on the strong recommendation of General Tempelhoff, gave him service as major in the Engineer corps. This enabled him to send for his family, and to attend to the publication of his book, which appeared in four successive volumes between 1797 and 1803.

The breaking out of war with France in 1806, followed by the battle of Jena, compelled Bousmard to serve against his countrymen. He joined the garrison of Dantzig, and gave zealous aid to the engineer of the place in preparing for resistance.

The siege commenced 1st April 1807. Bousmard was indefatigable—among other defensive operations, constructing an important field-work of counter-approach, to which Count Kalkreuth, the governor, gave the name of the engineer. On the 5th May, at six in the morning, Bousmard was killed. He had been on duty in the covered-way, and was waiting for the opening of a barrier to return to his quarters, when a bullet, plunging over the glacis, struck him through the shoulder. He was much regretted by the Prussians as a brave, active, and enlightened officer. The place surrendered on the 24th May.

Bousmard was a little man, of robust constitution and great industry. He was blessed with a frank and lively temper, of which exile and poverty never deprived him.

(Abridged from a notice in the third edition of the *Essai Général.*)

* Carlyle's *French Revolution*, iii.

A GLOSSARY

OF

MILITARY TERMS.

" Arma antiqua manus, ungues dentesque fuere
Et lapides et item sylvarum fragmina rami ;
Et flammæ atque ignes postquam sunt cognita primum ;
Posterius ferri vis est aciesque reperta."—LUCRETIUS.

——————" And thou hast talked
Of sallies and retires, of trenches, tents,
Of palisadoes, frontiers, parapets,
Of basilisks and cannon, culverins,
Of prisoners' ransom, and of soldiers slain,
And all the currents of a heady fight."—SHAKSPEARE.

[N.B.—*Antiquated Terms are marked thus* †.]

Abbatis, (French, *Abattre,* to hew down,) is formed by hewing trees and laying them on the ground with their branches outwards. When the trees are heavy, the branches pointed and well interlaced, and the whole covered from artillery fire, it is an excellent mode of obstructing access to a post.

Accoutrements. This term denotes the belts, pouches, &c., of a soldier.

Adjutant (Latin, *adjuvo*) of a regiment, is the assistant and minister of the commandant in all the details of duty and discipline. Through him the commandant receives reports and issues orders. Originally these duties appear to have been the proper province of the Major. A subaltern adjutant with the name of *Aide-major* is first mentioned about 1684.—Grose.

Adjutant-general is to an army what the adjutant is to a regiment. He may be called the commander-in-chief's prime-minister.

Admiral. (Span. *Almirante,* from the Arab. *Al Ameer,* the lord or chief. Fr. *Amiral,* from the form *Ameer ool* ——, commander of the —— fleet, army, or what not.) Applied by Joinville and other crusading writers, in its original sense, to the Sultan's Ameers. In Europe it appears always to have been applied to persons titularly, though often not actually, commanders of fleets.

ADVANCED-GUARD. A detachment of troops preceding the march of the main body.

AIDE-DE-CAMP. An officer attached to a general to carry orders, &c.

AMMUNITION. The matériel for charging firearms of every kind. Various articles served out to soldiers from the public stores receive this name; e. g. *ammunition bread, ammunition boots,* &c.

ANGLE, DEAD. Any angle of a fortification the ground before which is unseen, and therefore undefended from the parapet.

APPOINTMENTS, MILITARY. The accoutrements of an officer.

APPROACHES. A general name given to the trenches, &c., formed to cover the attack of a fortress.

†ARBALIST, or ARBLAST. (Lat. *Arcu-balista.*) A crossbow.

ARCHER. (Lat. *Arcus.*) A bowman. Arrows were shot by the English as late as 1627, in the attack of the Isle of Rhé, [Daniel,] and by the Highlanders in Montrose's army, (1645.)

ARMISTICE. (Lat. *armi-stitium*—a *still-stand of arms,* as Dugald Dalgetty renders it.) A truce, or temporary suspension of hostilities.

ARMS, A STAND OF. A complete set for one soldier.

ARSENAL. (Originally applied to dockyards only—said to be from the Arabic *Dár-saná,* House of the workmen.) A great magazine of military stores.

ARTILLERY. (From *Art.*) The name, in a large sense, is applied to all projectile machines of war. See the authorised version of the Bible, 1st Sam. xx. 40; and 1st Maccabees, vi. 5. In usual parlance it refers only to cannon, and in that sense signifies—

1st. Guns and their equipment.
2d. The troops serving them.
3d. The science of their construction and use.

The Royal Artillery, as a regiment, dates from 1705. Horse-artillery was first introduced in the Seven Years' War, in 1759.

ATTACK, FALSE. A feigned or secondary movement in the arrangements for an assault, intended to divert the attention of the enemy from the real or principal attack. Such a movement has been sometimes converted into a real attack and succeeded, when the main assault to which it was intended to be subsidiary had failed.

†BAILEY. (L. Lat. *Ballium.*) The outer works of a medieval fortress as distinguished from the keep.

†BALDRICK, or BAUDRICK. A shoulder-belt.

BALISTIC PENDULUM. A machine consisting of a massive block of wood suspended by a bar. It was devised by Benjamin Robins, the celebrated Quaker engineer, for his experiments on the initial velocities of cannon-shot — the shot being fired into the block, and the velocity calculated from the vibratory effect on the pendulum.

†BANDALEERS. Musket charges of powder in tin or copper tubes, worn dangling from a shoulder-belt, before the introduction of cartridges. They were not extinct in England till the reign of William III.

BANDEROL. A small flag used in marking out a camp, &c.

BANQUETTE. (Fr. A little bench.) A parapet high enough to cover a man's body is too high for him to fire over. A step or terrace is, therefore, constructed along the interior of the parapet for the musketeers to stand on, and this is termed a *banquette.*

BARBETTE. (Probably dim. from *Barbe,* the horse so called; as the cavalier has its name from *cavallo.*) An earthen terrace raised within a parapet, so high as to enable guns to fire over the crest of the latter, and therefore with a freer range than when worked at an embrasure.

†BARBICAN. (Arabic, *Bāb*—gate, *Khāna*—edifice; the Gate-house.) An outwork in medieval fortification covering the gate or head of the bridge, represented by the modern Ravelin; also a Bridge-head in the field. "For the security of his retreat, the King had erected a *Barbican* in front of the small bridge I have so often mentioned, and it was constructed in such wise that it might be entered on each side on horseback."—Joinville's *Mem. of St Louis,* (Bohn's edition,) p. 438.

†BARDED, or BARBED. A term applied to horses harnessed with plate-mail. They are found in use as late as the time of Edward VI.

BARRICADE. An obstruction formed in streets, avenues, &c., so as to block up access to an enemy. They are generally formed of overturned waggons, carriages, large stones, breastworks, abbatis, &c.

BASCULE BRIDGE. A drawbridge worked by a counterpoised beam.

BASE OF OPERATIONS. That line of frontier, of fortresses or strong country occupied by our troops, or of sea occupied by our fleets, from which our military operations advance, from which munitions are supplied, and on which a retreat may be made when needful.

†BASILISK, (from the fabulous reptile so called.) A name given to the monstrous pieces of artillery which the Turks used to employ at sieges.

†BASTILLE. A redoubt or small fort. Minor castles in Scotland used to be called *Bastle-houses*.

BASTION. (Old Fr. *Bastir*, to build.) In an extended sense, is any projection from the general outline of a fortress, from which the garrison is enabled to see, and defend by a flanking fire, the ground before the ramparts right and left. In the constructions of the Italian and French engineers, the Bastion is a spacious quadrilateral tower, having one angle salient towards the country. This has been the leading feature in most systems of fortification for the last three hundred years.

†BASTARD. A long gun of about 8 lb. calibre.

BATARDEAU. A wall across a wet ditch with sluices in it.

BAT-HORSE. (Fr. *Bât*, a pack-saddle.) A baggage-horse.

BAT-MAN. A servant in charge of the Bat-horses. Now it usually means a soldier from the ranks allowed to act as servant to an officer.

BATON. A short staff or truncheon borne by field-marshals as a symbol of their authority.

BATTALION. A body of infantry consisting, in the British service, of ten companies. "It may be considered as the unit of the modern tactical system—its characteristic feature being its capacity of receiving a simultaneous impulse from the word of command of its chief."—*Aide Mémoire.* At present, in the British service, Regiment and Battalion are practically almost synonymous; but a regiment may consist of several battalions under one colonel.

BATTERY. Signifies—

1st. Generally: any number of guns grouped, and in position for action.

2d. Specially: the unit of an artillery command, as a battalion is of infantry, or a squadron of cavalry. It usually consists of six pieces.

3d. Any work, permanent or temporary, considered merely as a position for a group of guns.

†BATTLE. Formerly was used—

1st. For a *division* of an army on the march or in array. Thus, "Their pikes being ranged in four battels, stood one in the tail of another."—Vere's *Com.*, p. 79.

2d. The main body of an army. "I took my turn of vanguard, battel and rereward."—*Ibid.*, p. 82.

†BAVIN. Old word for Fascine.

BAYONET. (From Bayonne, where it is said to have been invented.) The bayonet was introduced into the British army under Charles II., and superseded the pike completely under William III.

†BEAVER, or BEVER. (Ital. *Bevere*, to drink.) The part of a helmet covering the lower part of the face, which shifted on pivots to let the wearer drink.

BELLS OF ARMS. Tents in front of the quarters of each company, in which the arms are piled. In Indian cantonments for Sepoy regiments, the bells of arms are of masonry.

BELEAGUER. (See *Leaguer*.) To invest a fortress.

BERM. A narrow level space two or three feet wide, at the foot of a parapet, to prevent the mass of earth and other materials, of which it is composed, from falling into the ditch.

†Bilbo. (Because it came from Bilboa.) A sort of broadsword; also stocks for the feet.

†Bill. A sort of halbert.

Billet, to. To assign soldiers temporary quarters in the houses of the community.

Biscayan. A sort of large musket, or wallpiece.

Bivouac. (Ger. *Bewachen,* to watch.) Troops bivouac when they make the best of it for the night without encamping. Formerly applied to a night-guard of the whole army, when apprehensive of surprise.

Blindage. A temporary bomb-proof or splinter-proof roofing, constructed of timber and the like, to give cover to magazines, batteries, hospitals, &c.

Blockade. A place is said to be blockaded by land or sea when all ingress and egress is prevented by troops or ships of war surrounding it.

Blockhouse. A small fortified barrack, frequently used as a keep or place of final defence in a field-work.

Blunderbuss. (Probably from Ger. *Blinde Büchse,* a blind gun.) A short bell-mouthed carbine of large bore.

Body of the Place. The Enceinte of a fortress, or main line of bastions and curtains, as distinguished from outworks.

Bomb. A hollow iron shell filled with powder, and fitted with a fuze of such length as shall insure its explosion at the end of its flight. (See Note at p. 148.)

Bombard. To throw bombs or shells into a place, with a view to its destruction and to compel surrender.

†Bombards were enormous pieces of artillery used in the fifteenth and sixteenth centuries, usually throwing stone-shot. Froissart says that the men of Ghent (in 1382) under Philip Van Artevelde, in besieging Oudenarde, "fired a bombard of very great size, which was fifty feet (!) in length, and shot stones of an immense weight. The report of it was so loud that it seemed as if all the devils had broken loose."—Book ii., chap. 101. The same author mentions *portable bombards.*—Book ii., chap. 114. *Mons Meg* may be considered as a specimen of a great bombard.

Boom. (Dutch, *Boom,* a tree.) A chain of masts, a large cable, or other obstacle stretched across a river or harbour mouth, to protect a military bridge or bar access.

Boot and Saddle. (Ital. *Butta sella,* Put on the saddle.) The trumpet-call, on a march of cavalry, which precedes that of "*March.*"

†Boy. In old English phrase, *Boy* was specifically applied to camp-servants.—Grose, i. 183. So Fluellen—"Kill the *Poys* and the Luggage! 'tis expressly against the laws of arms!"* Similar is the old use of *Knave* for a servant, from Ger. *Knabe,* a boy. The term *Boy* is still preserved in this sense in the Madras and Bombay Presidencies, being applied, irrespective of age, to domestics.

Breach. An opening effected by artillery or mine in the walls and defences of a fortified place.

Break Ground, to. To commence the siege of a place by opening trenches, &c.

Breastwork. A hastily-constructed parapet, not high enough to require a banquette.

Bridge, flying. Consists of one or more barges moored by a long cable to a point in the centre of the stream. When the barge is properly steered, the current sweeps it from one bank to the other.

Brigade. (Ital. *Bregata,* supp. from Ger. *Brechen,* to break.) Two or more regiments, or battalions of different regiments, organised for combined service under one officer. Cavalry and artillery are likewise brigaded. The staff-officer of a brigade is termed Brigade-Major. In the Engineer service, the term Brigade is applied to groups of two or more officers arranged for the tour of duty in the trenches, and to the reliefs of men in sapping. The term is also frequently applied to trains of mules organised for the public service in the field.

Brigadier. Officer commanding a brigade. When the title is attached to his name, it implies that he has not attained the rank of a general officer. It is in this way used in India, but appears to be obsolete on the Home service.

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* *King Henry V.,* Act iv., Scene 7.

Brigadier-General. A regimental officer holding temporary rank as a general officer in command of a Division.

†**Brigand.** A species of irregular foot-soldiers frequently mentioned by Froissart. From their plundering propensities comes the modern use of the term.

†**Brigandine,** (from the preceding.) A coat of scale-armour quilted.

Bulletin. (Dim. of *Bulle,* Fr.) A term applied by the French to the published official account of an action by the general in command.

†**Bulwark.** (Ger. *Bollwerk,* Ital. *Balvardo.*) A bastion. "The fort being a square of four small *bulwarks.*"—Vere, p. 11.

Cadet. (Old Fr. *Capdet,* from Low Latin, *Capitetum,* a little chief.) A young gentleman appointed to the army, but not yet commissioned.

Cafila, Kafila. (Ar.) A convoy (of camels, generally.)

Caisson. (Fr.) A tumbril, or ammunition-waggon.

Calibre, or **Caliber.** (Lat. *Equilibrium.*) The diameter, or capacity of bore, of cannon or other firearms.

†**Caliver.** (Corr. of preceding.) A kind of light matchlock.

Calthrop. (Fr. *Chausse-trape,* or Catch-hose; in Dutch called *Scheurbroecken,* or Tear-breeks.) A crow's-foot, or iron implement with four spikes, strewed as an obstacle in ditches, on breaches, &c.

†**Camisado.** (Probably from Span. *Camisa,* because the enemy are caught in their *shirts.*) A night surprise.

Camp. The ground covered by an army under canvass.

Camp, intrenched. This phrase is applied to the elaborate fortification of positions selected to be occupied by armies, either on occasion, as of high moment to the operations of a campaign, or deliberately, as essential to the defence of a kingdom.

Campaign. The military operations of one season in the field.

Cannon. (Ital. *Canna,* a hollow reed—the barrel of a gun.) Now any piece of artillery; formerly the word was applied specifically to short heavy guns, as distinguished from culverins. The cannon appears to have been frequently of 40 or 48 lb. calibre; the *demi-cannon* about 24.

†**Cannon baskets.** The old English phrase for gabions.

Canteen. (From *Can.*)
1st. A soldier's drinking vessel.
2d. An authorised tippling-house attached to a barrack.
3d. A case containing kitchen and table equipage for camp use.

Cantonments. When troops are detached and quartered in different adjacent towns and villages, they are said to be placed in cantonments. In India, the permanent military stations are so termed.

Capital. In technical fortification, is an imaginary line bisecting the salient angle of a work.

Capitulation. The surrender of a fortress or army on stipulated conditions.

Caponière. (From the Ital. *Capannato,* a cottage, which is applied to the work in question by old writers.) A covered passage athwart the ditch of a fortified place, for the purpose either of sheltering communication with outworks, or of affording a flanking fire to the ditch in which it stands.

Captain. (Lat. *Caput.*) The present meaning of commander of a company is said by Grose to have been attached to the word about the time of Henry VIII.

Captain-general. This was the proper appellation of a commander-in-chief till Marlborough's time, if not later. The rank is sometimes still given on extraordinary occasions, as to Marquis Wellesley during his government in India.

Captain-lieutenant's commission was held by the senior subaltern of a regiment, who was in charge of the *Colonel's company.* The rank was abolished in His Majesty's service in 1772, but continued in the Indian army more than thirty years later.

Carbine. A short light musket used by cavalry. It is so called from a kind of light horse (*Carabins*) in the sixteenth century, whose weapon it was: the derivation of that term is unknown.

CARCASSES. Shells filled with a furiously-burning composition, intended to fire buildings, &c.

CARRONADE. A species of short iron gun, originally made at Carron Foundery. It is without trunnions, being attached to its carriage by a loop beneath.

CARRY, TO. To obtain possession by force of a military position.

CARTEL. A mutual agreement for the exchange of prisoners.

CASE-SHOT, or CANISTER, consists of iron bullets packed in a tin case (with a wooden bottom,) which is fitted to the calibre of pieces of artillery.

CASE, SPHERICAL. Iron shells containing musket-balls and a bursting charge of powder. Commonly called *Shrapnell*, after their inventor.

CASEMATE. (Span. *Casa*, house, and *Matar*, to murder. Thus, in Fenton's translation of *Guicciardini*, (1578,) book xii.:—"In the meanwhile, Peter of Navarre was labouring to carry the castle of Millan; and having won a *murdring-house* upon the castle ditch, which on the flank side had his prospect on the gate of Coma," &c. See also MURDRESS.) A covered flanking embrasure or battery; a bomb-proof vault, generally under the ramparts of a fortress, used as a barrack or a battery, or for both purposes.

CASHIER. (Fr. *Casser*.) To dismiss an officer penally.

CASINO. (Ital.) A country house, or enclosed villa—a term frequently occurring in foreign military narratives.

CASTRAMETATION. The art of regulating and laying out the encampment of troops of all kinds.

†CAT. (In old Fr. *Chas-chasteil*, cat-castle.) Name given to the movable towers used in ancient and medieval sieges. See pages 101 and 167.

†CATARACT. (Greek.) A portcullis.

CAVALIER. (Ital. *Cavallo*, a horse.) A work of more than ordinary height, raised for the purpose of commanding a particular position, or of adding to the defence of a place an additional tier of guns to be silenced, and an additional intrenchment to be captured.

CHAMADE. (Fr., from the Ital. *Chiamada*, and that from Lat. *Clamare*, to shout.) A signal made for parley by beat of drum.

CHAMBER. The place where the powder is deposited in a mine. The cavity, in a gun or mortar, which receives the charge.

CHANDELIER. A wooden frame which was filled with fascines, to form a traverse in sapping.

CHASSEURS. (Fr.) Species of light troops, both horse and foot.

†CHEMISE. (Fr.) An additional escarp or counterguard wall, covering the lower part of the escarp in medieval fortification.

CHEVAUX-DE-FRISE, (because said to have been first used at Groningen in *Friseland*.) A species of fence used in field fortification. It consists of a beam of wood with strong sharp stakes driven through it, in two or more different directions, up to their middle, so as to radiate from it like wheel spokes.

CHICANE. (Span. *Chico*, little, petty.) "The art of prolonging a contest by petty objection and artifice."—Johnson. Hence, in a military sense, to dispute every foot of ground by taking advantage of natural inequalities, &c.

CIRCUMVALLATION. Lines executed by a besieging army to protect the investment.

CITADEL. (Dim. from Ital. *Città*.) A fortress attached to, but independent of, a city or other permanent military position. It ought to command the latter, to be separated from it by an ample esplanade, and to be less accessible to attack, so that the fall of the place to which it is attached shall not involve that of the citadel, but this shall form, on a great scale, a keep or rallying-place to the garrison.

CLAYMORE. (Gaelic, signifying *Great glaive* or *sword*.) Properly, a great two-handed sword.

†CLOY. (Fr. *Clouer*, to nail.) To spike a gun. "They *cloyed* fifteene peeces of great artilleries which they won at the first charge, for that they had no opportunity to cary them to their campe."—Fenton's *Guicciardini*, book xii. *Clog* is used in the same sense. Thus, at the trial of Babington, &c., Sir C.

Hatton charged the conspirators with having plotted "to set fire to the Queen's ships, and to *clog* all the great ordnance."—Campbell's *Lives of the Chancellors*, ii. 142.

Coehorn. A small kind of mortar introduced by the great engineer whose name it bears. 4⅖ inches is the calibre of the British coehorn.

Column. A formation of troops narrow in front, and deep from front to rear. It is contradistinguished from *Line*, in which the troops display their front in its whole extent with their minimum depth of formation. Troops are in *close column* when the battalions, squadrons, or lesser bodies, which, ranged in succession from front to rear, form the column, are close together; they are in *open column* when intervals are preserved sufficient for wheeling into line when required.

Command, is the power of looking into, or firing into or over, one military work or position from another, derived from natural or artificial superiority of elevation.

Commissariat. The department charged with the provision of food, tents, &c., for an army.

Communication, line of. The line of friendly or mastered country, by which an army in the field receives its supplies from the rear, and maintains communication with its base of operations.

Compression, globe of. A fantastical name applied by Belidor to mines with immense charges, which he proposed to use for the destruction of countermines, and which were used successfully in the attack of Schweidnitz under Frederic II.

Constable, (Low Lat. *Comes stabuli,* Count of the Stables,) was, in the middle ages, the highest military officer under the King. The Duke of Buckingham, in the time of Henry VIII., was the last Constable of England.*

Contribution. A tax paid to a hostile force by the inhabitants of a town or country, to avoid being plundered.

Convoy. A guard of troops employed to escort provisions, stores, ammunition, or money, conveyed in time of war from one point or place to another. It is also applied to ships of war employed to protect a fleet of merchantmen during their voyage.

Cordon. The coping of the escarp or inner wall of the ditch.

Corporal. (From *Corps*, or Fr. *Caporal,* from *Caput.*) The lowest rank of non-commissioned officer, and *therefore* has been applied humorously by soldiers to some of the greatest commanders. Thus Napoleon was called "le petit Caporal;" Marlborough by his men, "Corporal John;" Gustavus used to call Tilly "the old Corporal." *Corporal of the Field,* in the seventeenth century, was an officer analogous to our brigade-major.

Corps. This word, which has crept into our language from the French, means literally a body, but is variously applied. In common English parlance, it usually designates a regiment. In Napoleon's wars, it was applied to large divisions of troops,—to large armies, in fact, detached from still larger ones. In the Russian campaign, some of the so-called "corps" numbered forty or fifty thousand men. By modern historians, the word is generally used in the more extended sense.

Cossacks. (Arab. *Kuzzák*, a robber; or, according to the *Penny Cyc.*, from a Tartar word signifying a mercenary light horseman. But it is much the same thing. See Brigand.) The half-Tartar tribes occupying the great plains on the eastern frontier of Russia in Europe, and who furnish a vast contingent to the armies of the Czar.

Counter-approaches. Trenches carried out by the besieged to intercept and check the works of the besiegers. Said by Allent (*Hist. du Génie*) to have been first executed at Rouen, when defended against Henri IV. in 1592.

Counterguard. A narrow detached rampart placed immediately in front of an important work, to protect it from being breached.

Countermines. Galleries excavated by the defenders of a fortress, to intercept the mines and destroy the works of a besieger.

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* It is curious to observe how many military titles have been degraded in their application; e. g., *constable*, *sergeant-major*, *corporal*, *maréchal-de-logis*, &c.

COUNTERSCARP. The outer boundary of the ditch, which is generally faced or revetted with masonry, to render the descent into the ditch difficult.

COUNTERSIGN. A watchword, demanded by sentries of those who approach their post.

COUNTERVALLATION, or CONTRAVALLATION, LINES OF. Fieldworks thrown up round a besieged place, to keep in the garrison.

COUP-DE-MAIN. A sudden and vigorous attack, for the purpose of instantaneously capturing a position. Sir Francis Vere uses in English *Handy-stroke.*

COUP-D'ŒIL. The gift of rapidly grasping and turning to the best account the contingencies of war, and the features of the country which is its scene.

COVER. Protection from observation and fire.

COVERED-WAY. A protected communication all round the works of a fortress, on the outer edge of the ditch.

CREMAILLÈRE. (Fr.) An indented or zigzag outline.

CRENELLATED. (Fr.) Loopholed.

CROWNWORK. A large kind of advanced work found attached to many fortresses. It consists of a bastion, two curtains, and two half-bastions.

CUIRASSIERS. Heavy cavalry wearing defensive armour for the chest. There appear to have been no cuirassiers in the British army from the Revolution till after the peace in 1815.

†CULVERIN. (From Lat. *Coluber,* a snake.) A long kind of gun, generally of about 18 lb. calibre. The gun at Dover Castle, called Queen Elizabeth's pocket-pistol, is a specimen of a large culverin.

†CULVERIN, DEMI-. A similar piece, of about 9 lb. calibre.

CUNETTE, or CUVETTE. A trench in the bottom of a dry ditch—an obstacle to the passage of an enemy, (especially if filled with water;) and also acting as a drain.

CURTAIN, in fortification, is that portion of the rampart which connects two adjacent bastions.

DEBOUCH. To march out of a wood, or defile, into open ground.

DECIMATION. The punishment of a corps by inflicting death on every tenth man by lot.

DEFILE. A narrow passage, in marching through which troops can present a narrow front only, which is dangerous in presence of an enemy.

DEFENCE, LINE OF. The direction of any face of a work which is to be defended by a flanking fire.

DEFILADING. The art of arranging the plan and profile of works, so that—

1st. Their lines shall not be liable to enfilade;

2d. Their interior, and their escarps, if of masonry, shall not be open to observation and fire.

DEMILUNE. An old name of the Ravelin. See note, p. 87.

DEPÔT. A place where stores are deposited; also applied to the reserve companies of regiments on foreign service.

DETACHMENT. Any amount of force separated from the main body to which it belongs, for a particular duty.

DISLODGE. To drive an enemy from any position.

DISMANTLE. To render fortifications incapable of defence, or cannon unserviceable.

DISPART. Half the difference between the diameter of the breach and that of the muzzle of a gun.

DITCH, in fortification, is an excavation made round the works, from which the earth required for the construction of the rampart and parapet is obtained.

DIVISION. A portion of an army, including infantry, cavalry, and artillery, and commanded by a general officer.

DOOLEE. (Hindustanee.) A palankeen litter, used in Indian armies, to carry sick and wounded men.

DRAGOON, till the early part of the last century, was the name of a description of troops which fought either as cavalry or infantry skirmishers. Hence the expression, "*horse, foot, and dragoons.*" It now means simply a regular cavalry soldier.

†DRAKE. (Lat *Draco.*) A small piece of artillery.

DUNGEON or DONJON. The great inner tower or keep of a medieval fortress.

En écharpe. (Fr.) Obliquely. *Echarpe* is a Scarf—*i. e.* a sash hung *diagonally* across the body.

Echelon. (From *Echelle*, a ladder.) A formation of troops in which the successive divisions are placed parallel to one another, but no two on the same alinement, each division having its front clear of that in advance, so that by marching directly forward it can form line upon it. Echelon is termed *direct* or *oblique*, with reference to the original front of the line. The former is a frequent disposition both for attack and retreat. The latter is used for changes of position in presence of an enemy, or for gaining ground to a flank.

Embrasure. A cut made in a parapet, in order that cannon may be fired through it.

Enceinte. Synonymous with "body of the place," *q. v.*

Enfilade fire. A fire of musketry or artillery which sweeps a line of works or troops from end to end in the direction of its length.

Engineers. (From *Engine*, and that from Lat. *ingenium.*) Officers trained to superintend the construction of works of attack and defence, and other special duties connected therewith. The term is applied at least as early as the reign of Philip Augustus, in France, (1206,) when they are called *engignours*,* and as that of Edward I. in England. Engineers, sometimes monks, are mentioned in the Scottish wars of the latter. In Edward III.'s siege of Calais they are coupled with carpenters, and similar artificers. Their principal duty was the construction of *engines* in siege operations. The occupation was, perhaps, in abeyance on the disuse of the ancient machines, but the engineers reappear again, in the beginning of the sixteenth century, as officers in charge of works both of attack and defence. In the Duke of Somerset's expedition to Scotland (1547) Sir Richard Lee is termed "Devisour of the Fortifications to be made." On the expedition to St Quintin's, in 1557, a chief engineer appears under the name of "Trench master," on an allowance of five shillings a-day. In rules for laying out a camp in the time of Elizabeth this duty is assigned, at least partially, to an "ingenier and his conductors," and sites are allotted to these, with subordinate *controllers of fortifications*. Among the artisans also is mentioned "a maister of the Gabions." With the staff of Lord Mountjoy's army in Ireland, in 1599, there is an "ingenere," now on ten shillings a-day, the same as the pay of the comptroller-general of the victuals, and just half that of the sergeant-major, (or adjutant-general.) In King Charles's army for the Scottish expedition, in 1639, there are two engineers at eight shillings, and two at six shillings, with six conductors of the trenches at two shillings each.† The engineers formed no distinct body in the English army till 1757, when a corps of engineers was organised with the ranks of *chief* (ranking as colonel,) *directors* (lieut.-colonels,) *sub-directors* (majors,) *engineers in ordinary* (captains,) *extraordinary* (2d captains,) *sub-engineers* (lieutenants,) and *practitioner engineers* (ensigns.) The corps got the appellation of Royal in 1788, and the peculiar titles are dropped in the army list for 1783. Previous to the establishment of regular corps the engineers were not necessarily soldiers. We find Benjamin Robins, who was both a civilian and a Quaker, sent out to India as chief engineer at Madras, where he designed the existing works of Fort St George, and died in 1751.

The French engineers were, as mentioned before, (p. 84,) embodied by Sully, but they appear to have derived their rank from commissions in infantry corps till the latter part of the reign of Louis XIV. At the peace of Ryswick (1696) they numbered six hundred officers, but were then reduced one half.

Epaulement. A term applied to various earthen works of merely passive defence, such as the short return or shoulder generally constructed at the flank of a field-battery, or the isolated mounds which have been sometimes thrown up by a besieging army to cover parties of cavalry posted for the protection of the trenches.

Eprouvette. (Fr.) A name given to certain contrivances for determining the strength of gunpowder by the recoil of a piece.

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* Daniel, *Hist. de la Mil. Franc.*

† Grose, *Mil. Ant.*

Escalade. (Lat. *Scala.*) The use of ladders in the assault of a fortified place.

Escarp, or Scarp. The side of a ditch next the rampart, which in permanent works is usually faced, or *revetted*, with masonry.

Esplanade. (Low Lat. *Ex-planata.*) The level space left between a citadel and the town buildings.

Evacuate. To withdraw from a town or fort in consequence of treaty, capitulation, or orders.

Evolution. A movement by which troops change their position for attack or defence.

†Falchion. (Lat. *Falx.*) A curved sword or short scimitar.

†Falcon. A small description of artillery—calibre 2 to 4 lb.

†Falconet. The smallest piece of artillery—calibre 1 or 1¼ lb.

Fascine. (Lat. *Fascis.*) A long cylindrical faggot of brushwood, used to revet the interior of batteries and embrasures, and for many other purposes of military engineering.

Fausse-braye, (*Braie* signifies *breeches*—hence the application to a work which covers the nether part of the escarp.) A secondary enceinte exterior and parallel to the main rampart, and considerably below its level. It is found in many Indian as well as old European fortresses.

Fencibles. Marching regiments, whose service was confined to the British Isles; raised first in 1759.

File. A line of soldiers drawn up behind one another. The general term means two soldiers, consisting of the front and rear rank men.

Firelock. A general name for the infantry musket.

†Fireworker. The old name of the junior rank in the artillery, now called second lieutenant.

Flank. 1st. The extreme right or left of a body of troops, or a military position.
2d. A part of a fortification constructed at an angle to the general line, in order to see the ground before the latter, and to defend it by a side or flanking fire.

Flank companies. The right and left companies of infantry regiments, generally grenadiers and light infantry.

†Flanker. A Flanking work. In 1591 an act of the Scotch Parliament authorised the citizens of Edinburgh to strengthen their walls with "Bulwarks and *Flankers.*"—Wilson's *Memorials of Edinburgh.* "The Turks going through the ditch were so cut off with shot from both sides, out of the *Flankiers*, that few of them could get to the desired bulwark."—Rycaut's *Hist. of the Turks.*

†Flanker, to, (used as a verb.) So Cromwell; "the enemy's army lying about four miles from us, intrenched by a line *flankered* from Edinburgh to Leith; the guns also from Leith, scouring most part of the line, so that they lay very strong."—*Despatch of* 30*th July* 1650, (Carlyle.)

Fleche (or Arrow.) A simple species of field-work, consisting of two faces forming a salient angle.

Forage. Provender for the horses of an army.

Forlorn hope. The term at present is only applied to the party detached to lead the storm of a fortress. But formerly it was applied to the advanced guard before the enemy, even on a march, (see Defoe's *Memoirs of a Cavalier* in many places,) or to the skirmishers commencing an action, (see Raleigh, quoted below,) or to the rearguard on a retreat, (see Vere below.)

> "His darters and slingers of the Baleares he sent before him to encounter the Roman Velites. These were loose troops, answering in a manner to those we now call by a French name, *Enfans perdus*—but when we use our own terms, the *Forlorn Hope.*"—Battle of Cannæ in the *Hist. of the World*, book v. 3 § 8.

And this passage is illustrated by the next—

> "Madam ——, I shall lose you too; you have put me like one of those that the French call *Enfans perdus*, that serve on foot before horsemen," &c.—Bacon to Queen Elizabeth, in Campbell's *Lives*, ii. 306.
>
> "His Lordship seeing all embarked before he went aboard, but those *forelorn* men that made the last retreat."—Sir F. Vere, *Commentaries*, p. 63.

Fort. Technically is applied to an enclosed work of the higher class of field fortification, but the word is used often in military works much more loosely.

Fortification. 1st. The art of forming, or strengthening by labour, a military position.
2d. A position so formed or strengthened.

Fosse. (Lat. *Fossa*, dug.) The French name for a ditch.

Fourneau. (Fr.) The chamber of a mine in which the powder is lodged.

Fraise. (Fr. for a ruff.) A row of palisades planted horizontally, or nearly so, as at the edge of a ditch, or on the steep exterior of a parapet.

†**Frise-rutter.** Dutch term corresponding to *cheval-de-frise*, used by old English authors. At p. 45, note, it seems used rather for *crow's-feet.*

Furlough. (Ger. *Urlaub*, leave, or perhaps *Verlauf*, expiration of a period.) Leave of absence to soldiers.

Fuse, (Lat. *Focus*, Ital. *Focile.*) A tube filled with a peculiar combustible composition, especially used in firing shells. It is cut to a length proportioned to the intended range of the shell, so that it shall burn down and explode the bursting charge just as the shell strikes the ground.

Fusil. A kind of light musket.

Fusiliers. A body of troops originally armed with fusils, which gave the name. There are now only four regiments so called in the British service, and they are no longer armed differently from others.

Gabion. (Ital. *Gabbia*, a large cage.) A cylindrical wicker basket without top or bottom, used to form the parapet of trenches in sapping, and for many other purposes of the field engineer.

Gallery. An underground passage, whether cut in the soil or built in masonry.

Galloper. A field-piece attached to a cavalry regiment.

Gantelope—corruptly Gauntlet. (From Ger. *Gassen laufen*, to run the length of street.) A military punishment, which consisted in passing along the whole line, and receiving a blow from every man.

Garrison. (Fr. *garnison*, from *garnir* to furnish.) The guard of a fortified place; the place itself; generally, the troops quartered in a town.

General. The highest *ordinary* military rank; first used in the English army about the time of Henry VIII.

Generalissimo. The commander-in-chief of combined armies.

Ghorchurra. (Hindustanee, literally *horse-rider.*) Applied, especially in the Punjab campaigns, to the irregular Sikh yeomanry.

Glacis. The parapet of the covered-way extended in a long slope to meet the natural surface of the ground, so that every part of it shall be swept by the fire of the ramparts. The glacis conceals the masonry of the escarp from distant cannonade.

Gorge. (Fr. the Throat.) The rear, whether opened or closed, of any work, having its aspect to a definite front.

Gorget. A crescent-shaped plate worn round the neck by officers till the present century. It represented the old cuirass, just as the strip of tartan now worn by Highland soldiers represents the capacious mantle of their forefathers.

†**Graffe** or **Graft,** (i. e. *graved* or dug, just like the corresponding French *fossé.*) "Divers of the enemy retreated into the mill-mount, a place very strong and of difficult access, being exceedingly high, having a good *graft* and strongly palisadoed."—Cromwell's *Despatch from Drogheda.*

Grenade. (Lat. *granatum*, a pomegranate.) A small shell flung by hand—properly *hand-grenade.*

Grenadiers. The tallest and stoutest soldiers in a regiment of infantry, selected and formed into a company, posted on the right of the battalion, and leading it in attack.

Guard. A certain portion of troops appointed to watch a position and prevent a surprise.

Guérite. (Fr.—same origin as English, *ware, ward.*) A turret or pepper-box, generally at a salient angle, for look-out and defence.

†**Guidon.** A cavalry banner; and the officer who carried it.

Gun. In military language, is never applied to small arms.

Gunner. A soldier employed to manage and discharge great guns; an artilleryman. In the British artillery, the private soldiers are divided into gunners and drivers.

Gunshot. The point-blank range of a gun, or thereabout.

†Habergeon. (Ger. *Hals*, the neck—*bergen* to protect.) A shirt of chain-mail.

Halberd. A pike with an axe in front, formerly carried by sergeants.

Hanger. (Scoticé *Whinger*, from Arabic *Khunjur*.) A short sword.

†Harbinger. (corrupt. of *Herberger* from *Herber* or *Harbour*, *i. e.* Quarters.) A quarter-master. Hence comes its present sense of a forerunner, because the quarter-master did, and does, precede a force to mark out a camp or assign quarters. The Quarter-master general was anciently called *High Harbinger*.

†Harquebus, Arquebus, Hackbut. (Ital. *Arco*, a bow, *Buso*, hollow—or Ger. *Haken*, a hook or crutch, *Büchse*, a gun.) The predecessor of the modern musket, usually fired with a wheel-lock, *q. v.*

†Hauberk. See Habergeon.

Haversack, (from old English *Haver*, oats; a regiment raised in the north of Yorkshire during the war had the name of the *Havercake lads*.) A coarse linen bag for carrying provisions issued to soldiers on service.

Havildar. (Hindustanee.) A sergeant in the native armies of India.

†Havock (perhaps the schoolboy's cry of *Halves*, or *Halvers*) was anciently the signal-word for general pillage. Hence, "Até by his side Cries havock, and lets loose the dogs of war." The beginner of the cry of havock was punishable with death, according to ancient English military statutes.—Grose, ii. 64.

†Herrison. A harrow for military purposes, or plank set with spikes.

†Herse. (Fr. for harrow.) A grated portcullis.

Holsters. (As if *Hold-sters*.) Leathern cases fixed in the front of a saddle to contain a horseman's pistols.

Honours of war. This expression is generally used in speaking of troops capitulating and evacuating a fortress. The nature of such "honours" depends very much on circumstances. In some cases the retreating forces depart scot-free, with colours, cannon, and baggage; in others, they retire to a distance, pile their arms, and then surrender as prisoners of war.

Hospital, field. The staff and apparatus for the surgical treatment of the wounded in the field, and the locality assigned for the resort of the latter to obtain it.

Hornwork. A kind of advanced work, akin to a crownwork, but consisting of only one curtain and two half bastions.

Household troops consist of the regiments of Life Guards, Horse Guards, and Foot Guards.

Howitzer. (Ger. *Haubitz*, perhaps from *ge-hoben*, elevated.) A short piece of artillery, much larger in calibre than a gun of the same weight. It is much used for discharging shells at low angles, and shot in ricochet.

Hulans. Irregular horsemen of the Ukraine, frequently mentioned in the wars of Eastern Europe.

Hurkara. (Hindustanee.) A messenger; one who brings intelligence; a scout.

Hussars. (Perhaps from Ar. *Házir*, ready.) Originally Hungarian horsemen, whose national costume is indicated in that of our dragoons so called.

Infantry. (The most probable derivation is from the Latin *Infans*, from which comes the Italian *Fante*, signifying a servant, like the old English *boy*, and French *garçon*. From *fante* comes undoubtedly *fantaccino*, and Fr. *fantassin*, a foot-soldier, as *sergeant* comes from *serviens*. In the Old Testament, soldiers are constantly called *young men*; and *jawán*, having the same meaning, is so applied in India.) The foot-soldiers of an army.

Intrenchment. A general term, denoting a ditch or trench, with a parapet for purposes of defence.

Invest. To take the initiatory measures to besiege a town, by securing every road and avenue leading to it, and by seizing the commanding positions. The business of an investing force is to prevent the garrison from receiving assistance or supplies, and to retain its ground till the arrival of the army.

with its breaching artillery, allows the commencement of the siege in due form.

†JACK. (Hence dimin. *jacket.*) A quilted or leathern cuirass.

JANISSARIES. (Turkish, signifying *New soldiers.*) The once formidable infantry of the Turkish empire, massacred by Sultan Mahmoud in 1825.

JEMADÁR. (Pers.) The junior rank of native commissioned officers in a Sepoy company.

JINJÁL. (Pers.) An Eastern wall-piece or matchlock of large calibre.

JUDGE-ADVOCATE. (Anciently *Judge-Marshal.*) An officer learned in military law, who superintends the proceedings of courts-martial.

JUZÁIL. (Pers.) A heavy rifle used by the Affghans.

KILLADÁR. (Pers.) In India, the commandant of a fortress.

KNAPSACK. A square case of canvass or leather, properly prepared for strapping on the infantry soldier's back, and containing the whole of his regimental necessaries.

†LANSPESADE, or ANSPESADE. (Said to be Ital. *Lancea-spezzada,* broken lance.) One doing duty as a petty officer, now called *Lance-corporal.*

†LANSQUENET. (Ger. *Lanz-Knecht.*) A lancer.

LEAGUER. (Ger. *Lager.*) A camp—generally of an investing army.

LIE UNDER ARMS. To remain in a state ready for action.

LIMBER, in artillery, (probably from the adjective *limber,* flexible.) The forepart of a travelling gun-carriage, to which the horses are attached. When brought into action, the gun is unlimbered by unhooking the trail of the carriage, and the limber is taken away a few yards in rear.

LINE. The term is applied to the numbered succession of the ordinary regiments of the regular army, and excludes special or local corps—such as guards, ordnance and marines, veteran battalions, fencibles and yeomanry.

LINES. A connected series of field-works, whether continuous or at intervals.

LINTSTOCK. A torch of slow match attached to a gun to light the portfire at.

LOCHABER-AXE. A bill or pole-axe used by the Highlanders.

LODGMENT. An intrenchment hastily constructed on a captured breach or outwork, in order to maintain the position against recapture.

LOOP-HOLES. Openings in a wall to fire muskets through.

LUNETTE. A work shaped like a detached bastion—*i. e.,* with two faces and two flanks. It is a frequent form of advanced work, or work thrown out beyond the ditch and glacis, to cover some site which it is desirable to occupy.

MACHINE, INFERNAL. A name applied to floating mines, used on several occasions, as at Antwerp in 1585.

MACHICOULIS. (Uncertain origin—perhaps old Fr., *masche-ès-col,* jaws in the neck.) A projecting parapet, or balcony, with holes between the corbels which support it, through which missiles can be directed down on the head of an enemy at the foot of the wall.

MAGAZINE, (Arab. *mukhzun,* a treasure-house,) in general, is a place in which stores, arms, ammunition, and provisions, are kept. The name is frequently restricted to a place for preserving powder.

MAJOR-GENERAL is now the lowest permanent grade of general officers. It formerly signified what we now call Adjutant-general, as it still does in France. In the translation of a well-known book, Jacquemont's *Letters from India,* General —— is constantly called *the* Major-general of the Bengal army.

MALINGERER. (Fr. *mal-engin,* evil device.) A soldier who feigns illness to avoid his duty.

MANTLET. A musket-proof shield of metal, sometimes used for the protection of sappers or riflemen during the attack of a fortress.

MARÉCHAL. The highest rank in the French army.

MARÉCHAL-DE-CAMP. Under the old régime, corresponded to our Major-general.

MARÉCHAL-DE-LOGIS, in the French service, appears to correspond to our Quartermaster-sergeant.

MARINES. A body of troops especially for the naval service, trained to encounter an enemy either at sea or land.

MARQUEE. (Fr. *marquise.*) An outer fly or roof cloth of a tent.

†**Marshal.** (Said to be from a Saxon phrase, signifying the Keeper or Master of the Horse.) In ancient times, the highest officer next to the Constable.

Field-Marshal. Since the time of George I., the highest English military rank, always granted very sparingly. Just thirty persons have been honoured with this title in the last hundred years, (including nine princes;) but the only memorable name among them is that of Arthur, Duke of Wellington. Not to be confounded with *Marshal of the Field,* in the seventeenth century, who was the head of the staff.

Martinet. (From General Martinet, a French officer under Louis XIV., who brought the bayonet into general use, and introduced a new mode of exercise.) A teasing pedant in the minutiæ of dress and discipline.

Masqued. 1st. A battery is masqued when it is so concealed or disguised, as not to be seen and recognised by the enemy until its fire opens.

2d. A work is also said to be masqued when, from deficiency of command or other causes, another work or body of friendly troops stands in the way of its fire.

3d. A fortress is said to be masqued when it is watched by a hostile force, in such strength and position as to bar the garrison entirely from acting on the offensive.

†**Medley.** (Fr. *Melée,* which we now use in its stead.) A confused hand-to-hand fight. "They fell immediately to hand-strokes, when the *medley* was terrible for a long time."—Fenton's *Guicciardini,* book x.

Merlon. The space in the parapet between two embrasures.

Mining. Embraces the art of subterranean excavation, and other measures appertaining to the destruction of works or buildings, by charges of powder lodged within them, or in the ground beneath them.

†**Minion.** (Fr. *Moyenne.*) A gun of about 4 lb. calibre.

Moors. Formerly applied by Europeans in India to the Hindustanee language, and the Mussulman population who used it; but now confined to the vulgar. It was borrowed from the Portuguese, who classed all turbaned unbelievers as *Moors,* without much regard to ethnography; just as in the Collect for Good Friday, the whole non-Christian body of mankind is classed as *Jews,* Turks, *infidels, and heretics.*

†**Morion.** (From Moorish; Ital. *Moro.*) An iron head-piece.

Mortar. (From its resemblance to a chemist's mortar.) A short heavy piece of artillery, generally of large calibre, used for throwing shells.

†**Mount.** Applied to the lofty batteries formerly used in sieges. "So he made *mounts* for shot against them, and other engines."—1 Maccabees, vi. 20. See cut at end of Glossary.

†**Murderer.** A great piece of artillery. Among the ordnance given up to Monk with Edinburgh Castle, in 1650, is mentioned "the great iron *murderer, Muckle Meg.*"—Wilson's *Archæology of Scotland,* p. 687.

†**Murdress.** A small flanking casemate or loophole. See Casemate.

Musket. (Probably from *Moschetto,* a gnat, or musquito; just as we find the small guns of Asiatic nations called *Zumbooruks,* or wasps.) An infantry firelock. Originally the musket was much heavier than the harquebus, which it superseded, and was fired with a rest.

Musket-proof. Capable of resisting the effects of musket-balls.

Muster. (Fr. *Monstrer,* to show.) A review of troops under arms, fully equipped, in order to take an account of their numbers, inspect their arms and accoutrements, and examine their condition.

Mutiny. (Probably from Lat. *Motus,* like the French *émeute.*) Rebellion against authority among soldiers.

Mutiny Act. The annual Parliamentary sanction of the military code, necessary to the existence of a standing army in this country.

†**Naccaire, Naker.** (Arab. *Nakkára,* common at this day in India.) A large kind of kettle-drum.

Naik. (Hind.) A corporal in the Sepoy armies.

Opening of the trenches. Synonymous with "breaking ground," or the commencement of the works of attack against a fortress.

Ordnance. A name applied to everything connected with the artillery service. Cannon are frequently designated pieces of ordnance.

Orillon. (Fr. Little ear.) A projecting tower at the shoulder of a bastion, covering the flank from exterior view.

Outworks. All the works constructed beyond the body of the place, such as ravelins, tenailles, covered-ways, &c.

Pah. The name of the stockaded intrenchments of the New Zealanders.

Palanka. A sort of stockaded intrenched-camp in use among the Turks on the Hungarian frontier.

Palisades. Palings of strong timber, frequently used in fortification. In a fortress the covered-way is generally lined and crossed with palisades.

Pandours. Irregular Hungarian infantry.

Parade. (Lat. *Paratus.*) To assemble troops in a uniform manner, for the purpose of regular muster, exercise, and inspection. Parade signifies also the ground on which the exercises are performed.

Parados. (Fr. Guard-back.) A traverse covering the interior of a work from reverse fire.

Parallels, in the attack of a place, are wide trenches affording the besieging troops a free covered communication between their various batteries and approaches. The first parallel is the first work of an attack which is laid down. Theoretically it is placed 600 yards from the covered-way.

Parapet. (Ital. *Para-petto,* guard-breast.) The screen which, in a fortified post, covers the troops and guns from the enemy's observation and fire—usually a bank of earth. It is made high enough to cover the tallest man, and thick enough to stand against the heaviest shot that is likely to be discharged at it.

Park of artillery. The whole train of artillery material belonging to an army in the field.

Park, engineer. The whole equipment of tools, stores, &c., belonging to the engineer department in the field, and the depôt assigned to them in camp.

Parole. 1st, The promise on honour to reappear when called for, given by a prisoner of war allowed to go at large.
2d, The password daily given out in orders by the general officer commanding in field or garrison.

Partisan. (Fr. *Parti.*) "The commander of a party detached from the main body upon some sudden excursion."—Johnson. It is generally applied to a leader of desultory or guerilla warfare.

Partisan. (Fr. *Pertuisan*—perhaps from Lat. *Pertusus.*) A sort of halberd.

†**Pataráro.** (Corr. of Lat. *Petraria.*) A sort of small swivel artillery, having a movable chamber.

Patrole. A small party of men under the charge of a subaltern or non-commissioned officer, detached from the guard, to keep moving along streets or roads, to maintain the order and regularity of troops, &c. Patroles are also sent out to gain intelligence of the position and force of an enemy.

†**Pavis.** A great shield or mantlet used in sieges.

†**Petronel.** (Fr. *Poitrinal.*) A piece between carbine and pistol.

Peon. (Hindust. a footman.) Applied in India to armed police.

Petard. A sort of bell-shaped metal pot, furnished with hooks or screws, so that, when charged with gunpowder, it can be fixed against a gate or palisade, and there exploded. It was first employed by Henry IV. of France in 1579. The thing is no longer in use, as powder in bags is found to be quite efficient for the destruction of such barriers.

Pettah. In southern India, applied to the enceinte of a town, as distinguished from the fortress to which it is an appendage.

Pierrier (Fr.) was applied anciently, first to an engine for casting stones, then to a small kind of cannon, (pataráro;) now to a mortar for discharging stones, &c.

Pioneers. Soldiers trained to work with spades, picks, axes, &c. Till the seventeenth century, large bodies of them usually accompanied armies, and performed the whole duty of intrenchment.

Piquets, outlying. Are detachments of cavalry or infantry, sometimes with light guns, posted on the front and flanks of an army in the field, in order to guard against surprise, and to keep reconnoitring parties at a proper distance.

Piquets, inlying. Are detachments told off to remain in camp, but fully accoutred, and ready to turn out instantly on alarm.

Pistol. (From Lat. *Fistula*, a pipe; or, say others, because first made at *Pistoia*.) The smallest firearm, requiring the use of one hand only.

Pivot. The officer or soldier stationed at the flank on which a company wheels.

Places of arms, in a fortress, are spaces widened at the angles of the covered-way, with a view to the compact formation of troops for a sortie, or for the defence of that outwork.

Platform. A timber floor, or pavement, on which cannon in battery are placed. In the old systems of fortification, *Platform* was a name given to an intermediate flanking work in the centre of the curtain, generally crowned by a cavalier.

Platoon. (Fr. *Peloton*, a ball, or *pellet*. The Latin, *Globus*, and the Hindustanee, *Gol*, having the same literal meaning, are applied also to bodies of troops.) A subdivision or small body of infantry. The word is obsolete, except in the term "manual and platoon exercise."

Point-blank. The position of a gun or musket when the axis of the bore or barrel, and the objects aimed at, are in the same plane, either horizontal or inclined. The point-blank range, therefore, is the distance at which a shot from a gun so laid will strike the object.

Pontoons. Buoyant portable vessels used as floats for supporting the platform of a military bridge. They were formerly in the shape of wooden troughs, or straight-sided boats. The standard pattern at present (Blanshard's pontoon) is a cylinder of tin. Tin pontoons are mentioned in the *Military History of Prince Eugene.*

Portcullis. (Fr. *Porte*, gate, and *coulisse*, a groove.) A gate sliding in a vertical groove.

Postern. A passage constructed under the rampart, affording a communication from the fort into the ditch, &c.

†**Pot.** An iron head-piece, generally with a brim.

Pouch. A case of strong leather, lined with tin divisions, for the purpose of carrying a soldier's ammunition. It is covered by a flap, to preserve the cartridges from wet.

Prame. A sort of flat-bottomed gun-boat, or floating battery.

Provost-Marshal. An officer attached to an army in the field, as a sort of head of police, having as his special duties the prevention of crime and disorder, the apprehension and sometimes the summary punishment of marauders and other offenders, the charge of prisoners and superintendence of punishments, &c.

Punt. (Lat. *Pons.*) A portable boat or pontoon. "A General of the Ordnance should have belonging to his train some certain number of boats or *punts*, with carriages to carry them on, for to make a bridge over unpassable rivers." —General Monk's *Observations on Military Affairs*, &c.

Quarter, to grant. To spare the life of a conquered enemy. It is not clear how the word comes to have this meaning. A French writer, quoted in Richardson's *English Dictionary*, says conquered soldiers were wont to offer a *quarter* of their pay as ransom—a custom probably invented to furnish the etymology. To give harbour or quarters to an enemy implies that his life is spared. But most probably the French *quartier*, in this sense, is a corruption of some foreign term asking mercy—sure to be mis-rendered by soldiers *—possibly of the Italian *misericordia*, understood as *Messires! Quartier!*

Quarters. Lodging assigned to soldiers.

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* "*French Soldier.—O prennez misericorde! Ayez pitie de moy!*
Ancient Pistol.—Moy shall not serve; I will have forty moys;
For I will fetch thy rim out at thy throat
In drops of crimson blood."
—*King Henry V.*, Act iv., scene 4.

Quartermaster. A regimental staff-officer, whose duty is to look after the assignment of quarters, the provision of clothing, and the distribution of ammunition, bread, firing, &c., for his corps, and in camp to mark out their lines in the position pointed out by the Quartermaster-general.

Quartermaster-general of an army in the field lays down the routes to be followed on a march, selects the position of the camp, and superintends the reconnoisance of the country, and the collection of intelligence in connection with these duties.

Quoin. (Old Fr.) A wedge used in elevating mortars and guns mounted on garrison or ship carriages.

Raise a siege, to. To abandon the siege of a place.

Rampart. (It. *riparo*, from Lat., *reparare.*) In a fortification, is the mass of excavated earth on which the troops and guns of the garrison are posted, and on which the parapet is raised.

Ramp. (Fr.) An inclined plane to facilitate ascent.

Rank and file. All those soldiers who enter the ranks and carry muskets.

Rapier. Formerly a long straight cut-and-thrust sword ; now generally applied to a small-sword.

Rasant. A French term applied to a style of fortification in which the command of the works over each other, and over the country, is kept very low, in order perfectly to shield the escarps.

Ration. An allowance of provisions issued to troops.

Ravelin. (It. *rivellino ;* perhaps from Lat., *re-vallare ;* or dimin. from *riva* or *rivera*, applied by old Italian writers to the counterscarp.) The most common kind of outwork. It is usually nearly in the form of a triangle, with the vertex salient. It stands in the ditch in front of the curtain.

Reconnoitre. To make one's self acquainted by personal inspection, as far as may be practicable, with the enemy's position and movements. Also, to survey, and draw in a rapid manner, ground of importance to operations of war, not represented in existing maps with sufficient accuracy or minuteness.

Redan, (or *Redent,* Fr.) A work consisting of two faces forming a salient angle.

Redoubt. 1st. (Fr. *Redoute.*) A small enclosed work without flank defence from its own parapets. 2d. (Fr. *Réduit.*) A keep or interior retrenchment.

Re-entering angle. An angle pointing inwards, as opposed to a *salient* angle, which points outwards.

Refuse. In military operations, to throw or keep back the troops, to avoid an engagement with an enemy advantageously placed.

Rendezvous. A place appointed for the assembling of any body of troops.

Reserve. A select body of troops kept back in action, to give support when it is needed, or to rally on in case of disaster.

†**Retirade.** (Fr.) A retrenchment.

Retrenchment. An inner defensible line, either prepared in the original construction of the works, or executed on the spur of the occasion, to cut off a breach or other weak point, so that the capture of the latter shall not involve that of the retrenched post. Sometimes used as synonymous with *intrenchment.*

Reveillé. The beat of drums at the break of day. After this the sentries do not challenge.

Revetment. A facing to the steep sides of a ditch or parapet. In permanent works it is usually of masonry; in field-works it may be of timber, turf, hurdles, or other material at hand.

Reverse fire. Fire on the enemy's rear whilst he is engaging your army in front.

Ricochet. (Fr. for *Duck* and *Drake.*) The repeated rebounding of round shot. By firing at a slight elevation with small charges in a direction enfilading the face of a work, shot are pitched over the parapet, and bound along the rampart from end to end, with most destructive effect on the guns and gunners occupying it. This is called ricochet fire.

Riflemen. Light infantry, armed with rifles instead of muskets, trained to be expert marksmen, and having a peculiar drill and exercise of their own.

Rocket. (Probably from its resemblance to the *rock* of a spindle.) A case filled with carcass composition, the violent combustion of which produces a continued recoil against the atmosphere, so powerful as to project the rocket to great vertical or horizontal distances. A stick is attached to guide its flight when fired. Made of pasteboard, it is used as a firework for signals; when of iron, it forms a terrible and destructive warlike projectile.

Roster. A tabular form showing the rotation of officers or soldiers for any duty.

†**Roundel.** A circular bastion; also a kind of target.

Rownee. (Hind.) The fausse-braye of an Indian fortress.

Ruffle. A kind of beat on the drum.

Sabre. (Ger. *Sabel.*) Properly a curved sword; now applied to a dragoon's cut-and-thrust sword, whether straight or curved.

Sabre-tash. (Ger. *Tasche,* a pouch.) A leather case slung to the sword-belt, originally intended as a portable writing and sketching case, but usually a mere piece of "*horse-millinery.*" *

†**Saccot.** A sand-bag.

Sack. To storm a town and pillage it.

†**Saker.** (Fr. *Sacre,* a kind of falcon.) A piece of cannon of five or six lb. calibre.

Salient angle, in fortification. An angle projecting towards the country.

Sally. A sudden offensive movement by the garrison of a fortified place, directed against the troops or works of the besiegers.

Sally-ports. Openings in the glacis which afford free egress and ingress to troops engaged in a sally or sortie.

Sand-bags. Bags of earth employed to repair breaches and embrasures.

Sap, Sapping. (Ital. *Zappa*—a pickaxe.) The art of excavating trenches of approach, under (musketry) fire of the besieged, is called *sapping,* and is practised by trained *sappers.* These men place gabions, one by one, along the intended line of parapet, and fill them rapidly, as they are placed, with the earth excavated from the trench. A trench so formed is called a *sap;* and when, under cover of night, or during slack fire, a line of many gabions can be placed and filled simultaneously, it is called a *flying sap.*

Saucisson. (Fr.) 1st. A large fascine; 2d. A hose for firing a mine.

Scarp, to. To cut down a slope so as to render it inaccessible.

†**Sconce.** (Ger. *Schantze.*) A redoubt, or small fort. Hence to *insconce* or intrench one's-self.

Scouts. Persons employed on the front or flanks of an army to observe and gain intelligence of the numbers and movements of the enemy.

Seconded. A term formerly applied to an officer whose company was reduced, he remaining on full pay till a vacancy occurred in another. The only application of the term at present appears to be in the case of Royal Engineer officers in civil employment, whose military rank and pay are in abeyance, but without obstructing their promotion.

Sentry or **Sentinel.** (Fr. *Sentir.*) A soldier placed in a position to watch the motions of an enemy, to prevent surprise, or to enforce such orders as he may be intrusted with.

Sepoy. (Pers. *Sipáhee,* a soldier.) A soldier of the native army in India.

Serjeant. (Lat. *Serviens*—applied in the middle ages to horsemen who were not knights.—Gibbon, lx., note.) The second rank of regimental non-commissioned officers.

Serjeant-major. The chief non-commissioned officer in a regiment. The title originally was the proper one of the *major.*

†**Serjeant-major-general.** Now called Adjutant-general.

Shaft. In mining, a perpendicular excavation.

Shot. Musketeers, as distinguished from pikemen and the like. So Talbot—

> "——— A guard of chosen shot I had,
> That walked about me every minute while."
> —*King Henry VI.,* Act i., scene 4.

Shrapnel-shells. See **Case-shot.**

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* *Bridal of Triermain.*

Siege. The process of deliberate attack on a fortified place.

Skirmish. (Ital. *Scaramuccia.*) A desultory engagement between small parties.

†**Snaphance.** (So called, Grose says, because used by marauders, whom the Dutch called *snap-hens*, or poultry-stealers! It is evidently from Ger. *Schnapp-hahn*, snap-cock, descriptive of its action.) A sort of firelock used in the seventeenth century.

Soubadar. (Pers.) The chief native commissioned officer of a sepoy company.

Spahis (same word as *sepoy*) were the principal cavalry of the Turkish empire in its palmy days.

Spike. To *spike* guns is to drive large nails into the vent, so as to render them unserviceable.

Splinter-proof. Strong enough to resist the splinters of bursting shells.

Spontoon. A light pike carried by infantry officers in the last century.

†**Spur.** A Redan, *q.v.* "Upon the line of circumvallation, at the distance of every two hundred paces, you must have a *spur* upon the line to flank it."—Gen. Monk's *Observations.* A sort of ravelin which formerly stood on what is now the esplanade of Edinburgh Castle was called the *Spur;* and a post near the barrier at Gibraltar is called the *Spur-guard.*

Squadron. (Lat. *Acies quadrata*, a square formation.) In the army, is a body of cavalry consisting usually of two troops, formerly of three.

Staff. A word somewhat vaguely used, and difficult to define. It is applied to those officers of an army, a division, or a regiment, whose duties refer to the economy of the body as a whole, and who are not attached to its particular subdivisions. Thus, in an army, the general, adjutant-general, chief engineer, quartermaster-general, &c., with the officers of their departments, form its staff; the brigadier, brigade-major, &c., are the staff of a brigade; the field-officers, adjutant, quartermaster, paymaster, and surgeons, are the staff of a regiment.

Star-forts. Forts with several salient angles, in the form of a star.

Stockade. A work in which a palisade of strong and closely-planted timbers constitutes the principal defence.

Storm. To make a powerful and vigorous assault on any position occupied by an enemy.

Strategy. The science of conducting the great operations of war.

Subaltern. Any military officer under the rank of a captain.

Sutler. A camp-follower, who sells drink and provisions to the troops.

†**Swines-feather**, or **Swedish feather.** An iron spit combined with the forked rest which was used with the musket in the seventeenth century, employed as a defence against cavalry before the introduction of the bayonet.

Tactics. Is often confounded with strategy. As distinguished from it, it is the *science* of military formations and movements; the *art* of handling troops —*i. e.*, of applying in the field, and to the exigencies of time and place, the evolutions which trained soldiers have been taught to execute.

Tamp. To pack the excavation of a mine after the charge has been deposited.

Tenaille. (Fr. *a pair of tongs.*) A low work in the ditch between two bastions, covering the curtain.

Tenaillon. An outwork appended to the ravelin in some old fortresses.

Toise. An old French measure of 6 French feet. The English fathom bears to the French toise the ratio of 1 to 1·066 nearly. Hence, for rough purposes, the English fathom may be accounted nearly equal to the French toise.

Tompion, †**Tamkin.** (Fr. *Tampon.*) A stopper placed in the mouth of a gun to keep wet out.

†**Traditores.** Flanking guns concealed behind the orillon.

Traverse. A traverse is a mound of earth thrown up to bar enfilade fire along any line of work, or passage, which is liable to it.

Trench. When a parapet is formed by throwing the earth outwards from the excavation, (as in approaches at a siege,) the latter is so termed.

†**Trench-master.** The title of the chief engineer with an English army in the sixteenth century.

Troop. A company of horse.

Trous-de-loup. Pitfalls dug as obstacles to an attacking force.

Trunnions of a gun. The cylindrical arms by which it is attached to its carriage.

Tumbrils. Covered carts, employed to convey ammunition, the tools of pioneers, miners, &c.

†**Turnpike**, in old works, sometimes means a *cheval-de-frise.*

†**Vaumure**, or **Vauntmure.** (Fr. *Avant-mur.*) A kind of fausse-braye. "They clapt up a strong and defensible covering, in manner of a penthouse, between the wall and the *Vaumure,* under which they shrouded themselves from the defendants."—Rycaut, *Siege of Rhodes.*

†**Vambrace.** (*Avant-bras.*) Armour for the fore-arm.

†**Vizor.** (Fr. *Viser.*) The movable mask of a helmet, enabling the wearer to *see,* as the *beaver* enabled him to drink.

Van of an army. The front or first line.

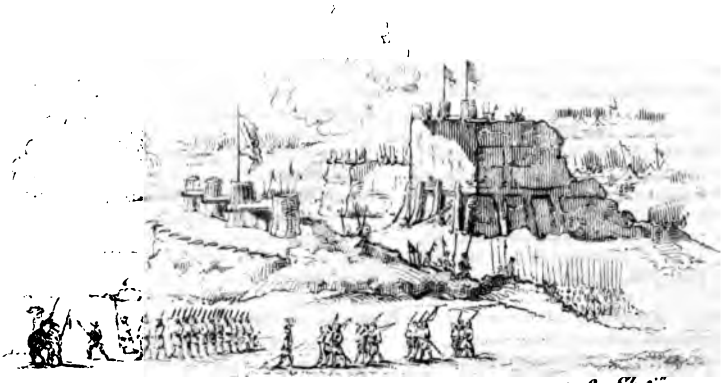
Vertical fire. The fire of mortars.

Videttes or **Vedettes.** Sentries placed on outposts and elevated points, so as to be able to observe advantageously the approach of an enemy, and to give early notice of his movements.

Wheel-lock. A sort of lock used anciently on arquebuses. It consisted of a roughened steel wheel, with chain and spring, which, when wound up like a watch, revolved rapidly, and struck fire against a flint held in the cock.

Wings (**of an army.**) The extreme right and left divisions.

Zumbooruks. (Pers. *Zumboor,* a wasp.) Diminutive swivel artillery carried on the backs of camels.



"Mounts for Shot"
(From the Siege of Grave by the Prince of Parma, 1586.)

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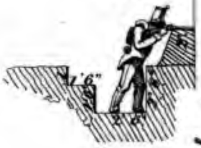

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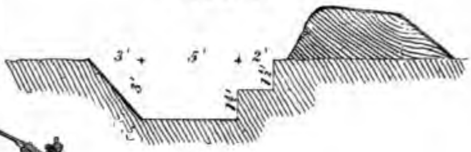

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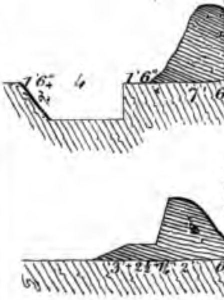

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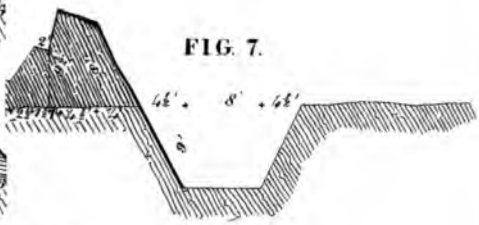

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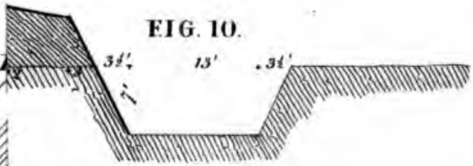

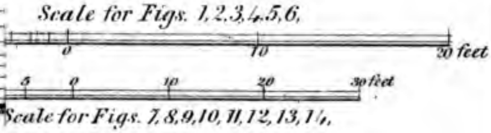
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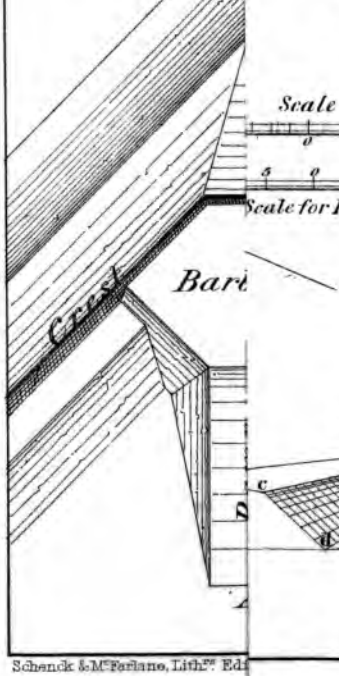

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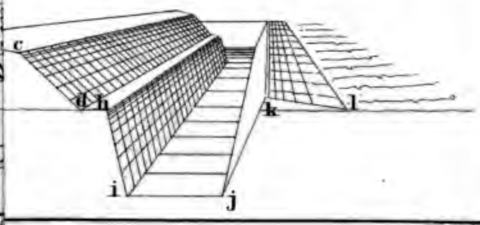

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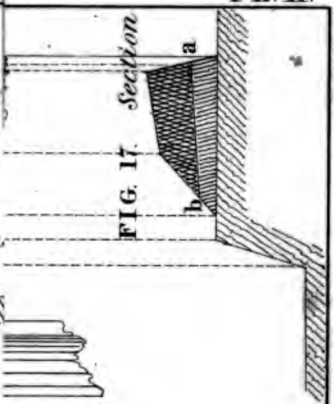

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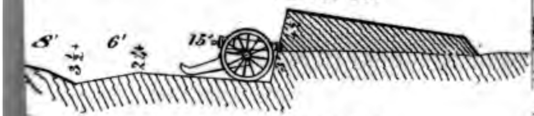

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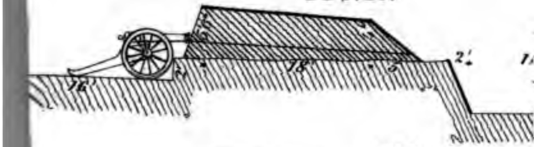

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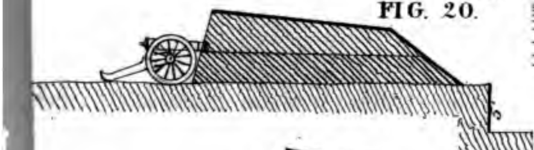

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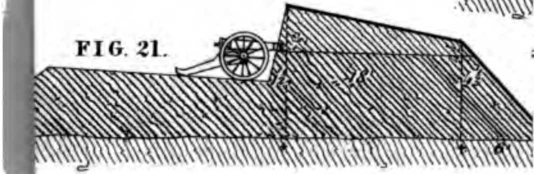

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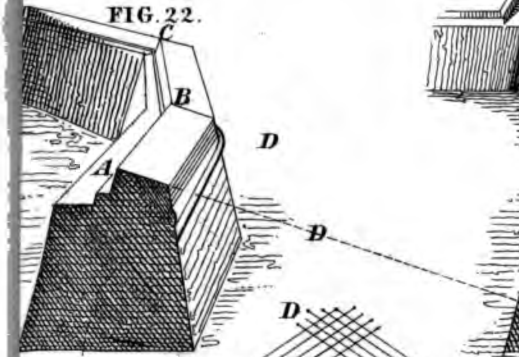

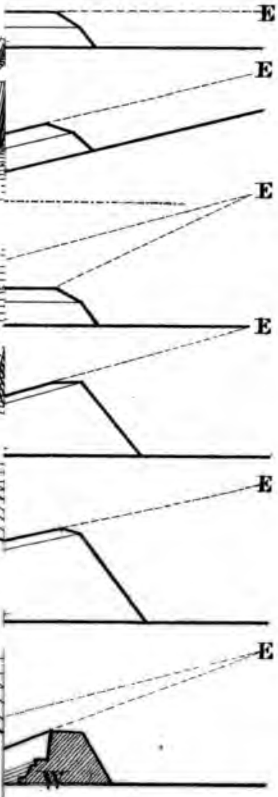

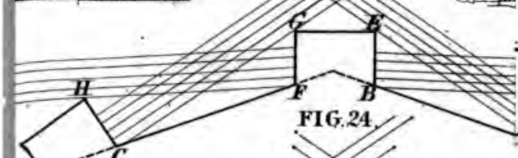

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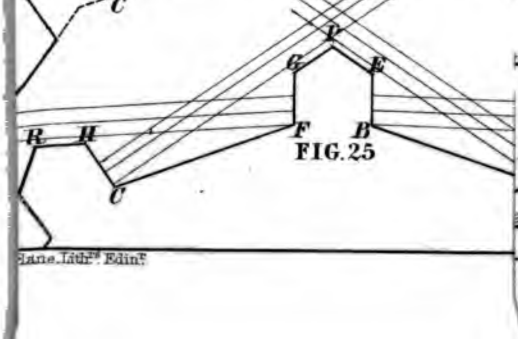

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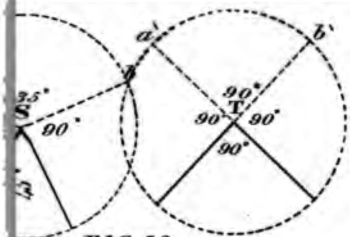

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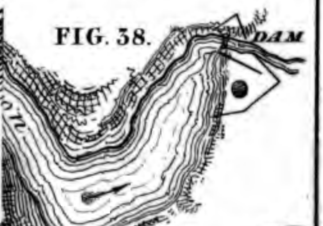

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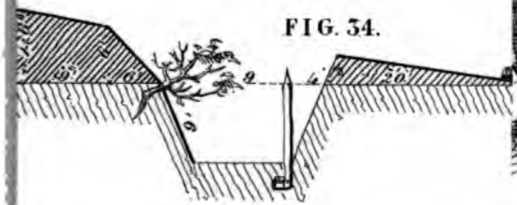

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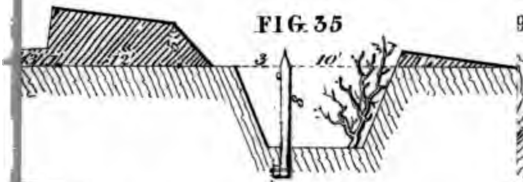

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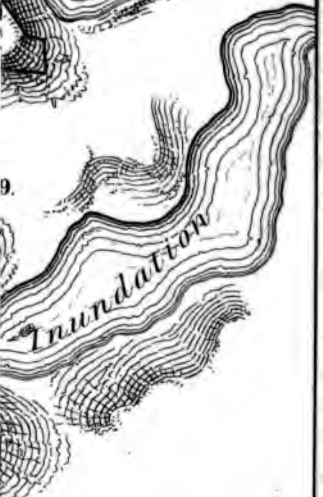

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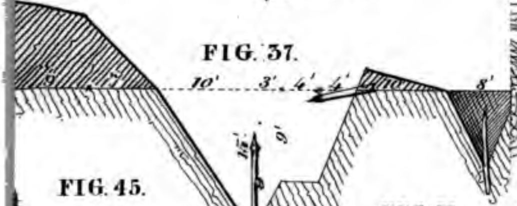

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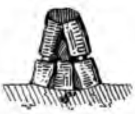

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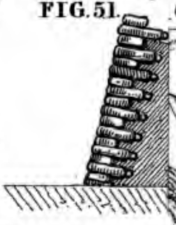

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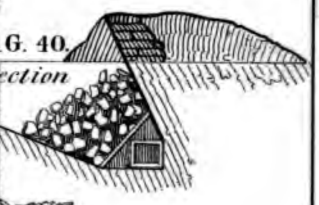

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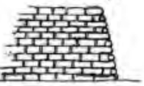

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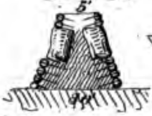

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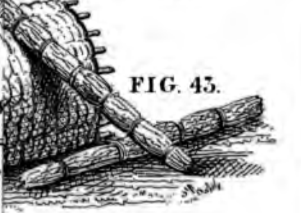

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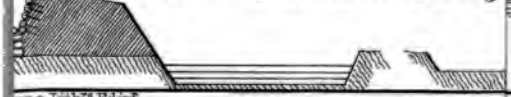

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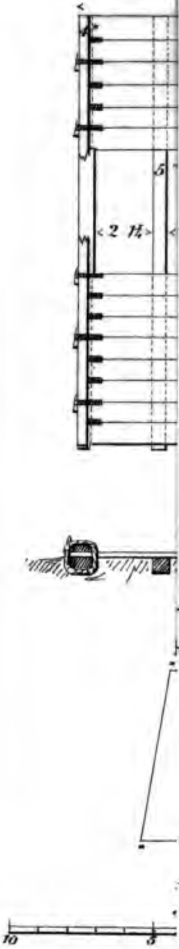

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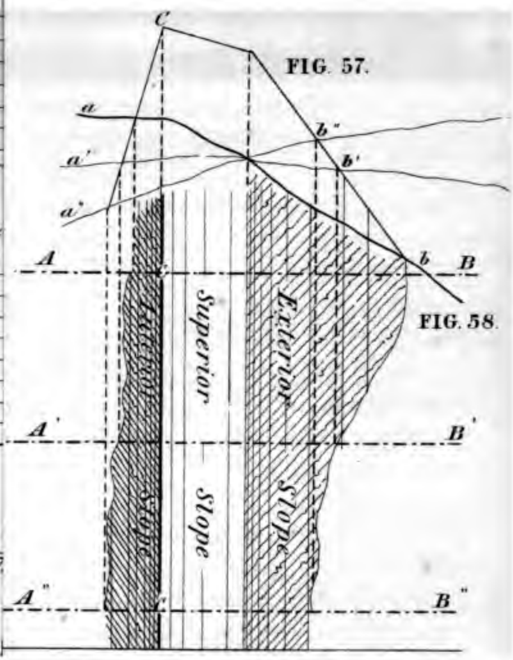

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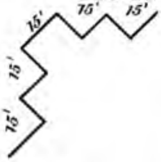

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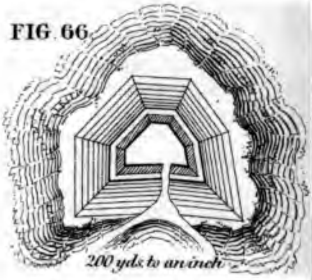

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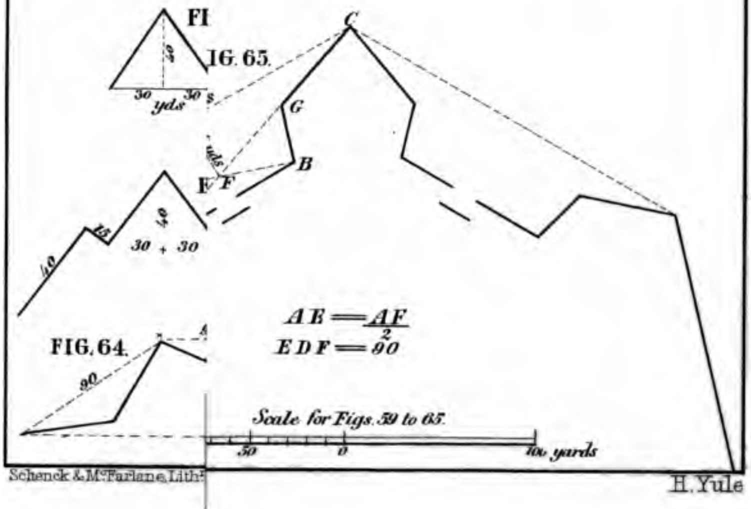

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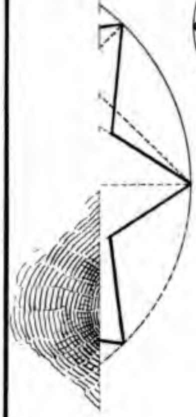

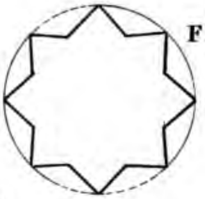

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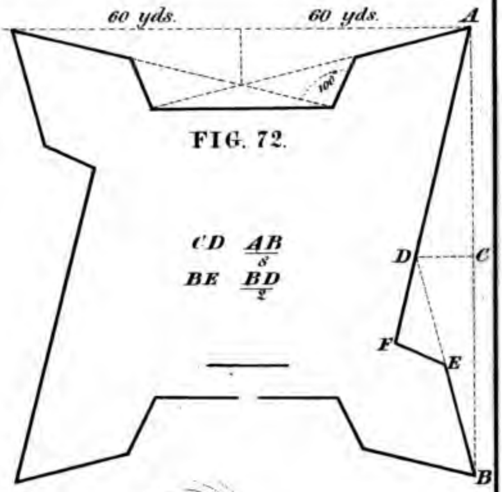

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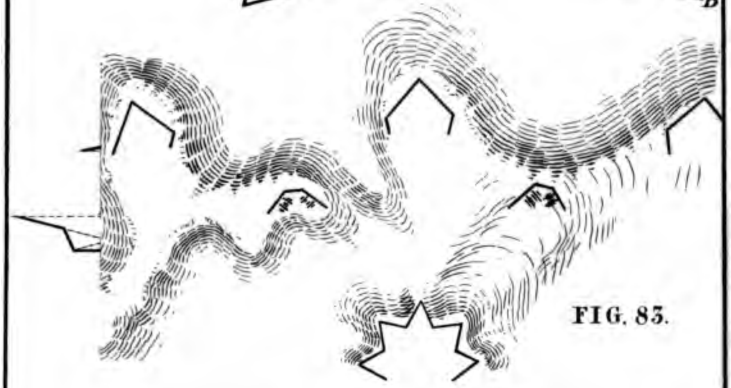

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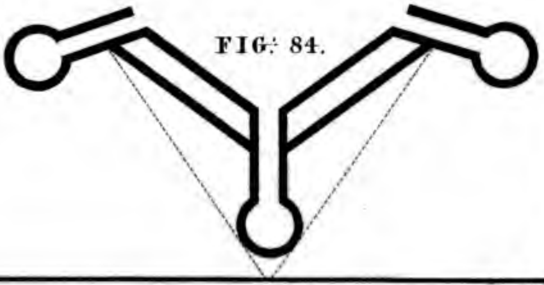

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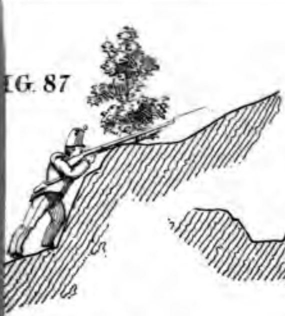

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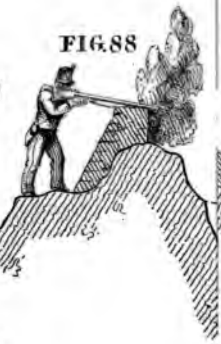

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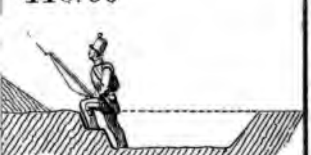

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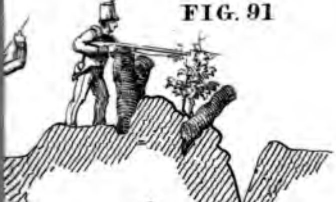

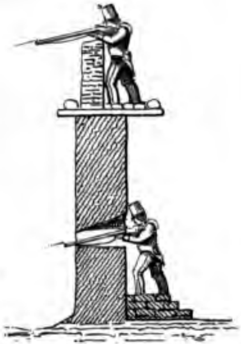

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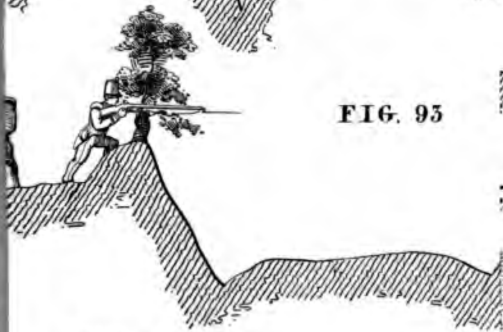

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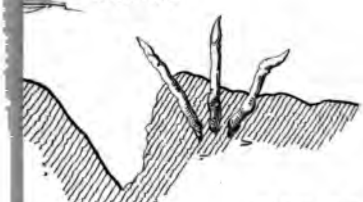

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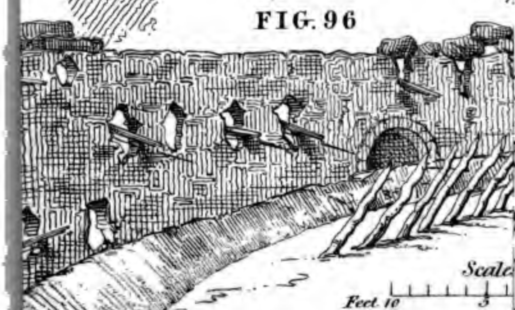

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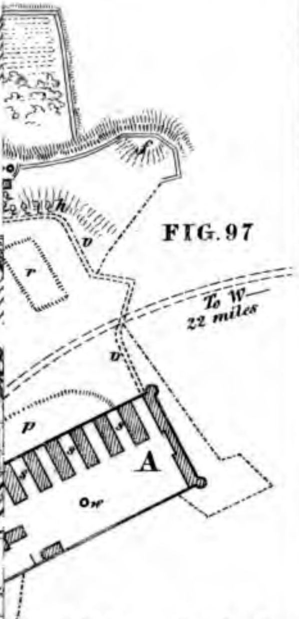

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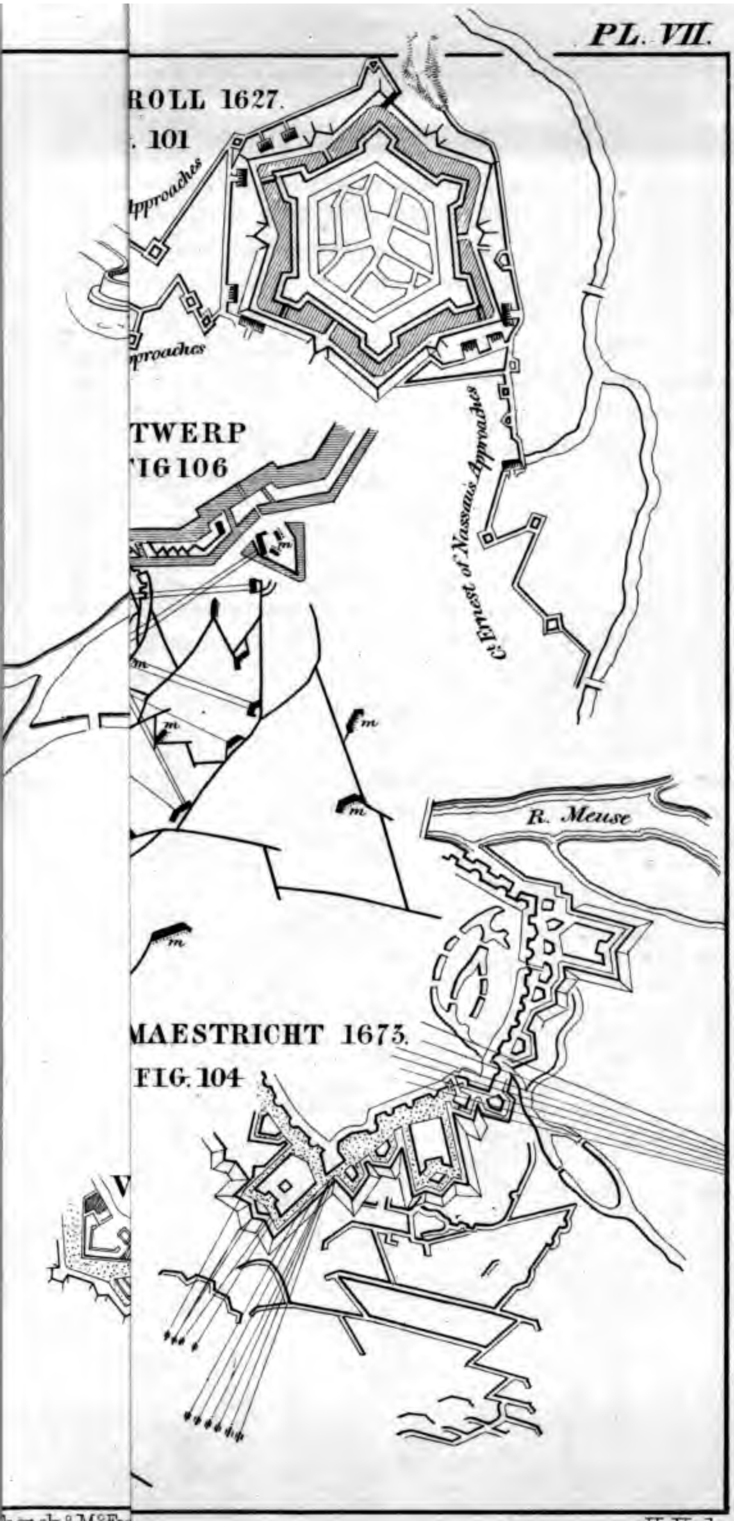

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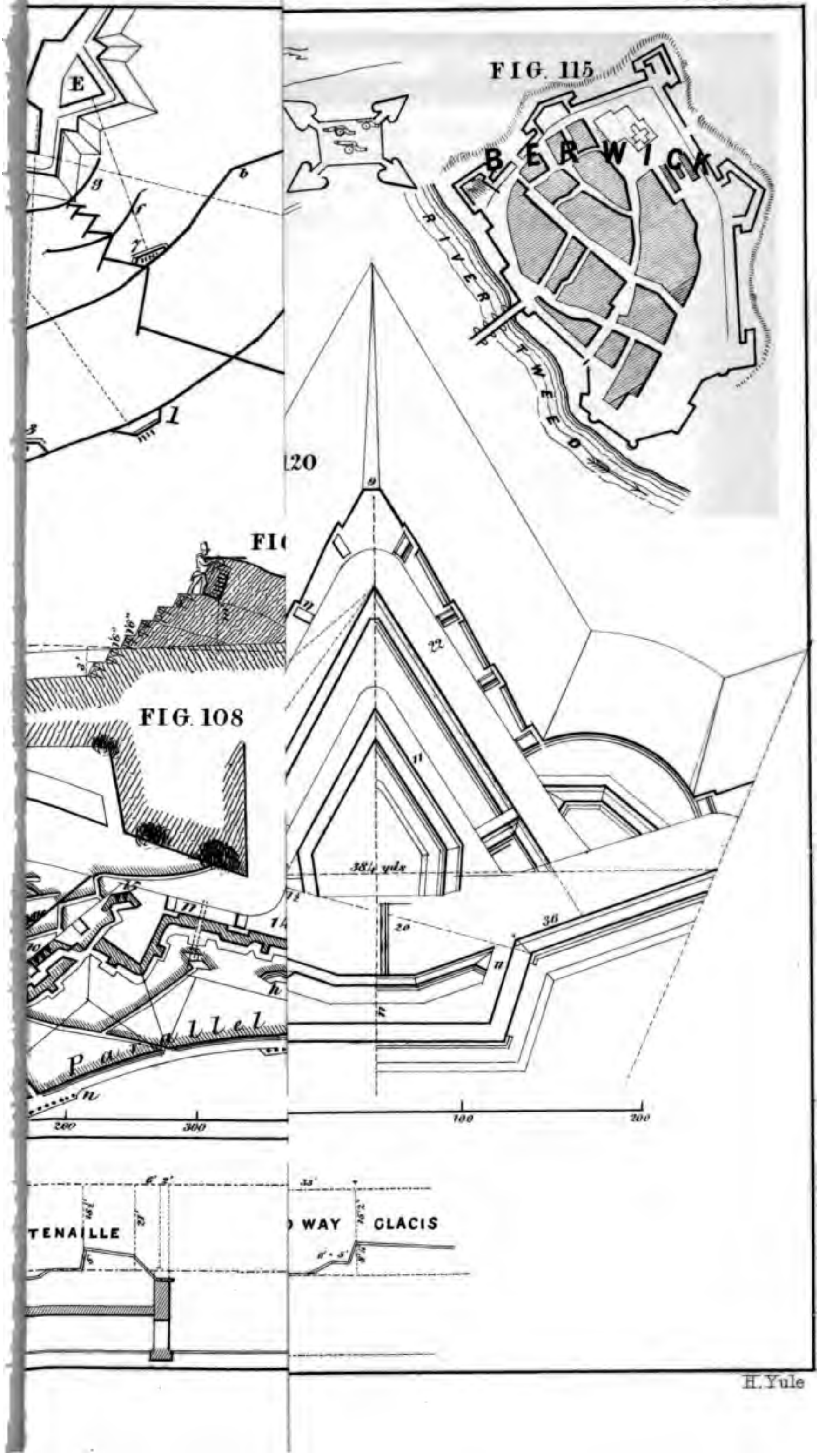

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